MAY-JUNE 2022

Machinery Lubrication

INDIA

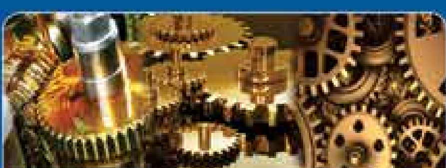
machinerylubricationindia.com

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)

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

May - June 2022

Machinery Lubrication
INDIA

machinerylubricationindia.com

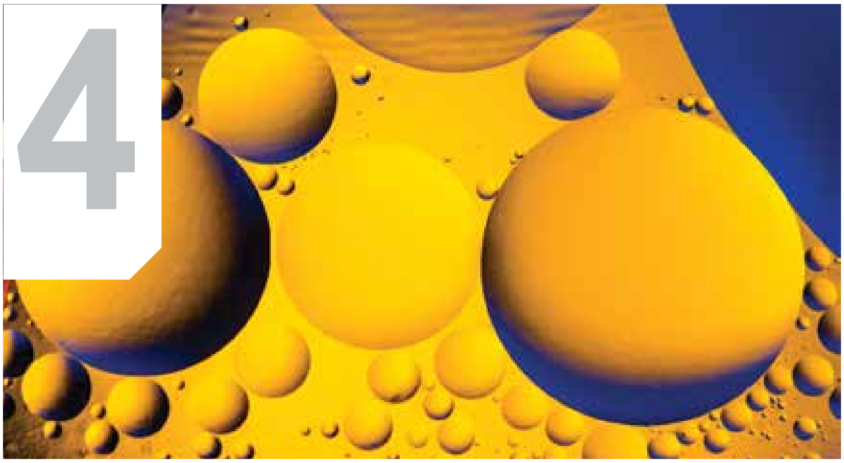
TAKING THE GUESSWORK OUT OF FILTER SELECTION

INSIDE

NORIA

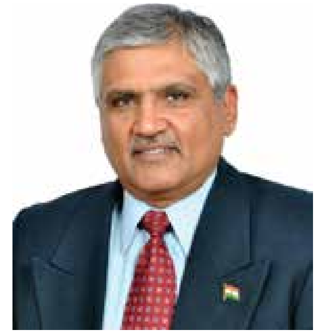
TABLE OF CONTENTS

Machinery Lubrication INDIA



EDITORIAL FEATURES

Publisher's Note



Lubricants or lube oils are the lifeblood of every 'oil-wetted' machinery. Such is the importance that an engine cannot practically work without the presence of lube oil. Lube oil not only ensures the smooth & resistance free movement of the internal components of an engine by isolating all parts from each other, but it also carries out a number of other very critical tasks like lubrication, cooling, cleaning & sealing etc.

While using a good quality oil for your engine is important, no oil can retain its purity forever. The engine system is not a closed loop network where you would pump the oil once and forget about it. Rather, the oil is prone to contamination through various internal and external sources which can introduce impurities into the oil. The internal sources form the majority of oil degraders due to impurities released from activities such as combustion, wear and the break down of hydrocarbons in the oil.

Now to remove these contimatents, we would need a suitable filter. This is a seemingly simple question with seemingly simple answers. The problem however is because so many different products exist in the marketplace, either confusion abounds or there is an attempt to oversimplify in order to cut through the confusion. The answer to the question is simple enough – filtration is using some method to remove suspended contamination from oil for either the protection of equipment (screening) or extending the life of the oil (cleaning). The solutions to oil filtration are not so simple and that's where the confusion begins.

Over the years, dozens of articles have been written on the use of filter carts for decontaminating new and in-service oil. For years, hydraulic shops and parts suppliers have built and sold simple filtration systems made with components intended for hydraulic systems to be used on hydraulic fluid. It all makes sense.Take this hydraulic gear pump, use this hydraulic hose and attach these hydraulic filters, and you get a filter cart built with hydraulic components to filter hydraulic fluid. This has been happening for decades, and with great success. It's easy to clean hydraulic fluid. Its relatively low viscosity makes it easy to push through ultra-fine filtration.

The success on hydraulic systems was so great that people started to imagine what an offline system could do for critical gearboxes and other high-viscosity applications. In many cases, the same systems were used on lubrication systems. Although the fluid may have moved through the system, in most (if not all) cases, the high-viscosity fluid would have sent even a new filter into bypass, allowing the fluid to move through the system unfiltered.

One of the more common oversights consumers make about filter carts is the size of their filter, or more specifically, the available surface area of filtration media and the level of filtration the media can provide. All filters are not created equal, and the most efficient filters may be too fine to properly decontaminate your lubricant.Filters are designed so that the fluid to be pushed through the media is stripped of solid particles greater than the pore size of that particular media. As the fluid passes through the media, a pressure differential is created. Factors that influence the pressure differential across the filter media include media pore size, total media surface area, fluid viscosity and the amount of dirt already captured in the filter media.

Besides the Cover Story on Filters, there are other articles on lubricants and lubrication. Please let us have a feedback on how you find the issues and your suggestions on topics you would like us to cover.

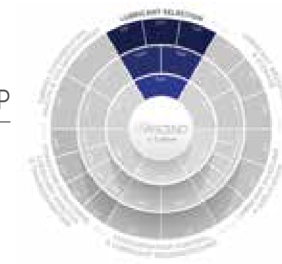
Meanwhile keep safe and healthy,

Warm regards,

Udey Dhir

Jeremie Edwards | Noria Corporation

Factor: S2P



3 Red Flags in Lubricant Supplier Agreements

More about this
ASCEND™ Factor

Factor:
S2P — Lubricant Supplier Selection

Level:
Platform (P)

Stage:
Lubricant Selection

About:
Selecting a lubricant supplier should be based on a methodology which considers fundamental compliance factors such as performance requirements, lubricant quality and service, troubleshooting support, technological advancement, innovation, service, delivery capacity and price.

Lubricant suppliers play an important role in asset management. A good supplier will ensure that your needs are met, and the right products are delivered consistently and on time. But like most businesses, a lubrication supplier's top priority is their bottom line. That's not to say that suppliers are trying to rip you off, but sometimes they may be selling you things you don't actually need. Here are some things to keep in mind when dealing with your lube supplier to ensure you're getting the products you need at a fair price.

1. Pressure for a "handshake" deal or lack of detail in an agreement

If agreements are not made with explicit and written documentation, there might be concerns about the validity of claims or promises made. Every detail of the lubricants provided should be clearly defined. Lubricant suppliers often offer training as well — this can be good, as long as the training isn't biased. The best arrangements for supplier agreements provide clear technical details, and if training is provided, it's better if it is created by an unbiased third party.

2. Focus on price

If the language of the agreement is focused on price comparisons and discounts, or if you're pressured to buy in bulk, there might be a conflict of interest. The primary goal of the lubricant is to ensure that we can maintain the integrity of our equipment and meet or exceed our reliability goals. Don't get me wrong, cost savings are a part of this decision, but if I spend 25% more on lubricants that last 50-75% longer, that higher initial cost may actually translate into a cost savings for the year. A good lubricant supplier will focus on getting you the right lubricants and then focus on price.

3. Technical expertise lacks clarity

Many lubricant technical specifications are a blend of hard data (viscosity, additives, base oil type, operating temperature range, etc.) along with some marketing language that describes the unique nature of the lubricant formulation and common applications. The lubricant supplier agreement should provide some further data validating expectations on lubricant properties, quality and delivery:

- Cleanliness and dryness
- Delivery times
- Expediting fees
- Ongoing technical support (industry specialization, etc.)
- Software for managing lubricant supplies and reordering

If these details are absent, or if the language of the agreement is vague, don't be afraid to ask questions and get clarifications. A good lube supplier is knowledgeable and has nothing to hide — they will happily provide you with all the details you desire.

Do your best to determine the methodology the supplier may use to recommend lubricants. Do they use a standardized approach to identify the right lubricant for the application? Do they focus on the application requirements, or do they simply match the properties of the lubricant currently in use? Are synthetics versus mineral oils selected based on the ORS? Are considerations like ambient conditions, risk of moisture/other contaminants, viscosity index, etc., part of their calculations? Have they had a conversation with you about the reliability goals and criticality of all your equipment? All of these factors play a role in our reliability and should be addressed. ***ML***

About the Author

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

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 59 - Issue 3, May-June 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.

TAKING THE GUESSWORK OUT OF FILTER SELECTION

BY JIM FITCH

By Jim Fitch, CEO, Noria Corporation

By now, organizations that have advanced reliability and maintenance programs understand the intrinsic value of lubricant cleanliness. Noria and many others have published extensively on this subject. The business case is rock solid: the cost of preventing oil from becoming dirty (exclusion and removal) is a small fraction of what machine repairs and downtime will cost down the road. The sad truth is that many asset owners are under the a false impression that their filters are doing a good job and their oils are clean enough.

Just as it is true that not all lubricants are alike, the same holds true for filters. Filter manufacturing is a very competitive and diverse industry from the standpoint of cost, quality and performance. Owners of large equipment fleets can spend well over $1 million per year on filters. Industrial plants with extensive asset lists can face a similar filtration spend. A single filter element used on a large circulating oil system can cost more than $1,000.

While there are commodity (economy grade) filters of all types to choose from, as with many products, the greater value and quality often come from selecting the premium option at the high end of the price range. Yet, most premium high-performance filters can look very similar to cheaper, lower cost filters at first glance. Published data on filter performance by their suppliers is often embellished or out-of-date. After all, a filter supplier would never publish anything other than stellar performance data, and this data is usually the product of their own laboratory.

My background in filter testing runs deep. Before Noria, I was the CEO of Diagnetics, Inc., the world's largest manufacturer of filter test stands. These test stands evaluated filter performance to SAE and ISO standards. We also tested thousands of filters on our equipment. During that time, we became very aware of a common discrepancy between measured filter performance and the perceived quality of those same filters among the user community.

Getting the Biggest Bang for Your Filter Buck

Just like lubricant performance testing, in many cases, it is wise to get filters tested by an independent laboratory. For instance, if you have three filter brands you are considering, it would be advisable to get an objective, unbiased confirmation of the following questions:

1. Which filter gets the oil the cleanest (capture efficiency across the life of the filter)?
2. Which filter lasts the longest (dirt-holding capacity)?
3. Which filter has the lowest flow resistance (pressure-flow performance)?
4. Which filter is manufactured to the highest quality and fabrication integrity (free of random defects)?

Of course, you don't need independent testing to answer the final question: which filter is the cheapest?

Fortunately, there are excellent standards available for answering questions 1-4. Sadly, testing filters to these standards has not been widely available to the user community. These standards are:

- ISO 2942: filter fabrication integrity (quality)
- ISO 16889 and ISO 4548/12 (performance): particle capture efficiency, dirt-holding capacity, flow resistance
- ISO 23369:2021 (performance): similar to ISO 16889 but for filters exposed to cyclic flow and other real-world conditions

There are numerous other test standards available, but these offer the greatest opportunity to optimize filter selection from the standpoint of value and performance. Together, these standards work towards achieving consistent lubricant cleanliness (within the target cleanliness) at the lowest possible cost.

Figure 1. Interior multipass system circuits and components. The dilution system and particle counters are mounted on the left interior panel.

Figure 2. Above the sink on the left is where the filter being tested is mounted. The circular middle sinks are filter test system reservoirs. The larger injection system reservoir is on the far right.

Figure 3. Funnel-shaped sinks achieve turbulent flow, enabling controlled homogenous distribution of particles across a range of sizes during the test sequence.

What Multipass Filter Testing Looks Like

A multipass test stand is used to perform all the tests listed above except for fabrication integrity. This can be done for filters of numerous different sizes, configurations, and flow rates. A multipass test stand is a highly engineered machine with many circulating loops, a contaminant injection system, two on-line optical particle counters and a 100:1 continuous dilution system (to ensure particle count accuracy). See Figure 1 for a visual idea of the engineering and science behind standardized filter testing.

The forward-facing "bench side" of the test stand has three circular funnel-shaped reservoirs, as shown in Figure 2. The larger reservoir (far right) is the injection system reservoir that supplies a precisely metered distribution of particles (e.g., ISO Medium Test Dust) to the filter test loops during the test cycle. Filter testing can take several hours from start to completion. Together, the filter test loops can handle flows ranging from 0.26 gpm to 106 gpm (1 L/min to 401 L/min).

To start a test, the filter is mounted above the shallow rectangular sink on the left using the hardware corresponding to the required flow rate. In Figure 4, a small spin-on filter is shown mounted to the low-flow rate test loop. The high-flow test loop is positioned above. The lower left hardware shows a flat-sheet holder for testing swatches of filter media in the same way a cartridge or spin-on filter might

Figure 4. The left-side test sink shows a small spin-on filter mounted and ready for testing.

Figure 5. Filter tests conditions are defined at the computer station before the start of the test. This is followed by a warm-up stage. During the test, data appears on the screen circuit diagram.

TEST RESULTS

Element Integrity

Bubble point to ISO 2942: ______ Wetting fluid: ______

Differential pressure

Filter housing (kPa): 22.4 Clean element (kPa): 4.6

Clean assembly (kPa): 27.0 Final DeltaP element (kPa): 304.6

Test Goal Terminal DP(kPa): 327.0

Differential pressure versus contaminant added

Time interval	(minutes)	DeltaP (kPa)	Mmass (g)	Time interval	(minutes)	DeltaP (kPa)	Mmass (g)
10%	0:07:30	5.10	45.66	60%	0:44:58	37.37	273.95
20%	0:14:59	6.42	91.32	70%	0:52:27	81.71	319.61
30%	0:22:29	8.55	136.97	80%	0:59:57	144.99	365.26
40%	0:29:58	11.18	182.63	90%	1:07:26	220.60	410.92
50%	0:37:28	17.82	228.29	100%	1:14:56	304.60	456.58

Retention capacity

ISOMTD mass injected (g): 456.58 ISOMTD retained capacity (g): 454.19

80% upstream concentration (mg/L): 26.99 Dust holding capacity (mg/cm²): ______

Filtration ratio ßx(c) (If the size value is blank, see multiple values on Graph C2: Beta vs. Size)

Average Filtration Ratio:	2	10	75	100	200	1000
Size (µm(c))	<4	4.6	7.7	8.2	9.3	12.7

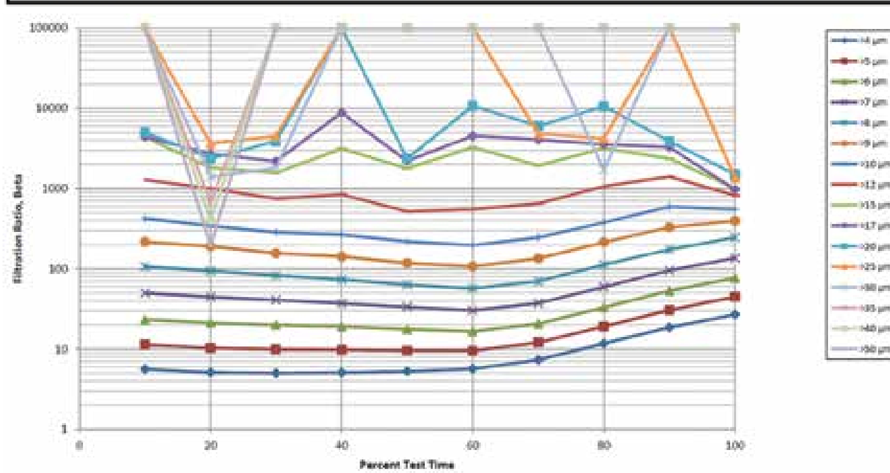


Figure 6. Data from a multipass test report. The table at the top shows dirt-holding capacity and particles sizes corresponding to filtration ratios at 2, 10, 75, 100, 200 and 1000. The plot shows how filtration ratios change dynamically over time as particles become more heavily retained by the filter.

be tested. Flat-sheet testing evaluates the performance of the media only, not the entire filter element collectively.

Before each test, the filter flow rate and terminal pressure drop are entered manually at the computer control station. Most other operating conditions, including contamination injection rate, temperature, dilution ratio, etc., are predetermined by the standard and operating system. Other test protocols would be required for cyclic flow testing (ISO 23369).

Multipass testing enables filters to be tested to an international standardized protocol. This enables published data to be compared apples-to-apples to other candidate filters tested using the exact same protocol. It also removes subjectivity and differences in data interpretation. For instance, what do you understand when a filter is represented as being 10 microns nominal? How about 10 microns absolute? Or Beta (10) of 10? Multipass testing is a consensus standard written by industry peers. As such, it removes this uncertainty and random interpretations of such performance claims. Figure 6 shows data from a sample multipass test report to ISO 16889.

Fabrication Integrity Testing

You may be surprised to hear that each filter that is sold is a filter that has never been tested. Multipass filter testing is destructive, time-consuming and relatively expensive. It is also really good at assessing the first three performance assessments in the above list. While many filter companies may share or publish multipass filter test data with customers, often these tests were last performed years ago. Filter media changes, as do other manufacturing specifications. These differences influence test performance in a variety of ways.

Fabrication integrity testing (also known as bubble-point testing) presents another option and is often done on each filter before multipass testing. Fabrication integrity testing is non-destructive and relatively cheap, although it is rarely done on filters that are sold. To perform this test, the filter element is submerged in a bath of alcohol, and air is slowly metered into the center of the filter. The increasing air pressure is monitored using a standard monometer. When the first stream of air bubbles emerges through the filter element (point of least resistance), the pressure reading of the monometer is noted. This is the bubble point.


Figure 7. The test bench on the left is used for bubble point testing (ISO 2942). The image to the right shows a stream of bubbles from a defective opening in the filter media. The air pressure reading when the first bubble appears is recorded as the bubble point.

	Brand A	Brand B	Brand C
Filter cost (per element)	$125	$110	$95
Tested dirt-holding capacity (ISO 16889)	250 gms	160 gms	125 gms
No. of filters required to remove 200 kgs of dirt (fleetwide) per year (filters changed based on pressure drop)	800	1250	1600
Annual filter consumption cost	$100,000	$137,500	$152,000
Filter change labor cost (est. $25 each)	$20,000	$31,250	$40,000
Total annual cost (filter and labor)	$120,000	$168,750	$192,000
Savings compared to the **economy** Brand C	**$72,000**	$23,250	$0

Figure 8. Financial analysis of three filters based on dirt-holding capacity. Data from filter testing guides the decision. In this case a premium, long-life filter is the economical best choice, saving $72,000/year.

The higher the pressure, the greater the filter's fabrication integrity. There is a good correlation between the bubble point and the mean pore size of the filter media. Most filters that fail the bubble point test are not marginally defective but instead exhibit major issues, including damaged filter media, seam cracks and defective end-cap adhesive seals. You may be surprised to learn that at least 10% of all new oil filters (regardless of the application) will fail the bubble point test in this way. This statistic can vary between filter brands, type and quality (e.g., price point).

Using Testing to Reduce Your Filtration Spend

The value of incorporating filter testing when planning your purchases is best demonstrated using a simple financial analysis. Let's say your company spends $152,000/year on a single type of hydraulic filter. You are aware that there are at least three filter suppliers that make comparable filters (size, configuration and performance). The prices of these filters are different. In the past, the low-cost option was selected by procurement. For the purpose of this analysis, we'll assume the capture efficiency (Beta Ratio) of these three filters to be the same. Which one should you select? The lowest price? Let's do the math. See Figure 8.

Getting a filter's dirt-holding capacity is rarely as simple as going to a website or looking at a product data sheet. In fact, I'll bet you can't find it anywhere. Why is that? ISO 16889 (industrial oil filters) and ISO 4548 (diesel engine oil filters) both include dirt-holding capacity as a standard reported value.

In the example of the three candidate filters, we'll estimate that 200 kilograms of dirt must be removed over a year's time for the entire fleet. In the table to the left, the differences in filter price are shown. The three filters were tested independently on a multipass test stand, and the dirt-holding capacities were found to be 250, 160 and 125 grams, respectively. Based on the 200 kgs of total dirt, the number of filters required is 800 for the premium high-priced filter and 1,600 for the economy brand.

Also included in the financial analysis is the labor cost of replacing a filter. I used $25 per filter, but there are many other hidden costs I did not include. These include purchasing, stockroom and handling, planning and scheduling, used filter disposal, waste oil handling and disposal (oil from inside the filter), record keeping, etc.

When the price per filter (including labor) and the dirt-holding capacity are compared together, the economical best choice is the premium, long-life filter at a savings of roughly $72,000 per year. Please note that my data is hypothetical. Don't assume the premium filter to always be the long-life filter. Do the testing and get real data. The cost of testing these three filters would be less than $4,000 — a small fraction of the potential savings.

As mentioned, testing reveals other critical performance differences between filters as well. The three most important are particle size retention (how clean will the filter get your oil), flow resistance (affects energy consumption) and fabrication integrity (likelihood of random manufacturing defects). A larger number of filters will be needed to get statistically meaningful data for fabrication integrity. These other performance factors influence the service life of machine components (bearings, pumps, gears, etc.), labor and material cost of repairs, downtime costs, energy consumption costs and much more.

Where to Start

If I had a fleet of machines and a large annual filter consumption bill, I would compile a list of filters consumed in high volume and those that individually cost the most. This is your Cost Factor List. Next, I would look at mission-critical machines and the filters used there. For such machines, there is a need for far greater performance to ensure reliable and consistent contamination control. This is your Criticality Factor List. Many filters will appear on both lists.

By ranking the filters from two lists, you focus testing where the economic opportunity is the greatest. For more information on how to get your filter tested, contact Noria Corporation. ***ML***

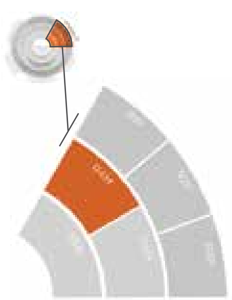
About the Author

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.

Paul Farless | Noria Corporation

THE DO's AND DON'Ts OF LUBRICANT CONSOLIDATION

More about this **ASCEND™ Factor**



Factor:
R4M—Inventory Management:
Level:
Management and Training(M)
Stage:
Lubricant Reception And Storage
About:
Inventory management must define optimal inventory levels, prioritize keeping lubricants in appropriate and clean environments, and optimize inventory investments by adopting a FIFO (First In, First Out) strategy.

In the interest of reducing purchasing costs and streamlining storage and handling, many organizations have substantially slashed the number of lubricant SKUs (stock keeping units) they use. They have also re-engineered the precision of their lubricant specification. There are many real benefits to these consolidation initiatives if done correctly. Let's go over some of the DO's and DON'Ts of lubricant consolidation.

DO's

DO Review each application for lubricant requirements and compatibility — When we recommend lubricants, we base the recommendation on several factors, one of the most important being the individual needs of each lubricated asset throughout the plant. This includes considerations such as viscosity for sufficient film thickness based on operating and environmental conditions. Additionally, compatibility with the current lubricant is important; a thorough flush may be required if the lubricant is incompatible.

DO Base all decisions on criteria such as volume, price robustness, and machine count — These are just a few factors that go into our lubricant recommendations. While cost justification is usually the most important factor in any facility, lubricant selection shouldn't be based solely on the lubricant cost itself. Rather, it's a cost-benefit justification, with long-term savings achieved from optimizing the selection.

DO Create a team of all stakeholders to be involved in the process — By stakeholders, we mean leaders: a team full of leaders that take ownership of the program. This may include participants from different departments, such as maintenance, operations, reliability, engineering, etc.

DO Ensure you have the correct amount of storage and handling devices to avoid mixing — The facilities we visit are often just starting their lubrication program. One of the main strategies we encourage is developing a proper reception and storage plan, including the proper hardware to maintain cleanliness, control quality and prevent cross-contamination (i.e., bulk oil storage, dedicated transfer pumps, etc.).

DO Set a review period every two years to ensure consolidation efforts are maintained — This is more of a QA/QC (quality assurance/quality control) check to stay on top of the program and ahead of the game. A lubrication program isn't achieved; it's maintained. This goes back to taking ownership of the program: continuous improvement is the name of the game.

DON'TS

DON'T Try to reduce to a single lubricant — This is why we prefer using the term "Lubricant Optimization" instead of consolidation. We are trying to reach a level where the facility will have a manageable number of lubricants while still covering the vast array of applicable ranges required to lubricate each asset properly.

DON'T Rely solely on the lubricant supplier to select lubricants — The lubricant supplier is sometimes unfamiliar with a specific plant's needs and may recommend lubricants based on their experiences with other plants. I am not saying that the suppliers are out to ruin the program, but they don't necessarily go into a high level of detail when making lubricant selections. On the other hand, they may not have a specific lubricant/additive package that meets the standards set by the Original Equipment Manufacturer (OEM) or the facility for a certain piece of equipment. If the incorrect lubricant is chosen based on a limited selection, it could cost the facility a lot of money down the road.

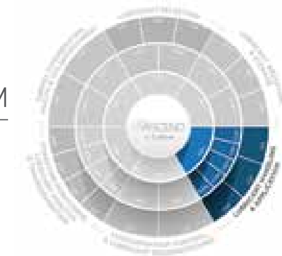
DON'T Select lubricants based on price alone — We all understand that cost is king. However, when we move past the initial sticker shock, having a generous budget for lubricants is paramount. What you spend on the correct lubricant will save the plant from having to spend an even larger amount of money when the machine goes down, especially when factoring in replacement and man-hour costs.

DON'T Buy tools or build a lube room prior to consolidation — Establishing a good lube room is the best foundation for a lubrication program. If this is done before optimization, you could easily overspend on storage and handling equipment when that spend has the potential to be greatly reduced by understanding the exact type and quantity of lubricant that will be used.

DON'T Add a lubricant for each new machine that's installed — When selecting a lubricant for newly installed equipment, it's not uncommon to defer directly to the OEM's primary recommendation. While this works, it does not satisfy the plantwide consolidation needs, and the problem will get worse with each new machine that gets added. *ML*

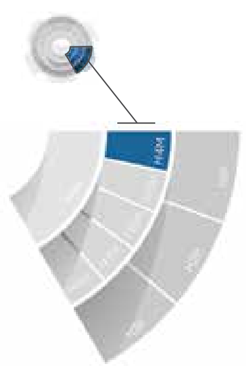
Travis Richardson | Noria Corporation

Factor: H6M



How Borescopes Can **Help Inspect Equipment**

More about this **ASCEND™ Factor**



Factor:
H6M – Machinery Inspection Devices and Practices

Level:
Management and Training(M)

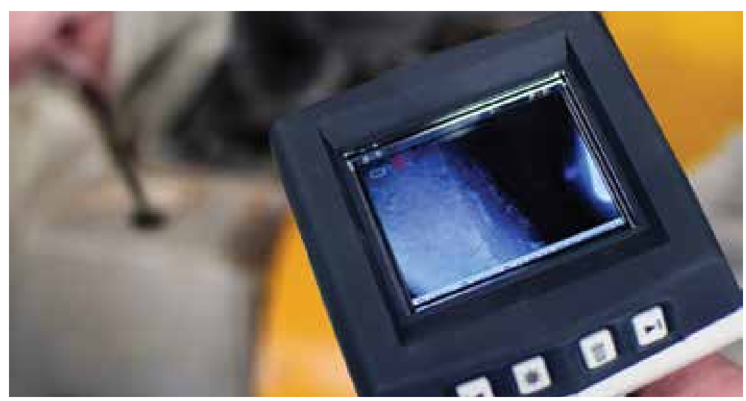
Stage:
Lubricant Handling & Application

About:
Routinely inspecting machinery lubrication systems and recording inspection results is an easy and efficient way to avoid equipment failure.

If you have been in the reliability realm for any length of time, you have probably been taught the importance of machine inspections; you may have even performed some. Sensory inspections using sight, sound, and smell are probably the most common forms of inspections. On more critical equipment, a thorough, in-depth inspection might be performed using tools such as oil analysis, thermography, or ultrasound. While these are great inspection tools, they only give us information about what might be going on in the machine from the outside. One tool that can allow you to get actual footage of the inner workings of the machine is a borescope.

What is a Borescope?

A borescope, in simple terms, is a viewing device wired to a camera at the end of rigid, flexible tubing. The camera is sent inside the machine via the tubing, allowing the viewer to inspect the machine parts and surfaces from outside the body (such as the case of a gearbox). These devices can be customized to fit the need of the application by changing the size of the camera, adding an articulating head to widen the viewing range, or even adding a light to the end for a better view.



Where Would You Use a Borescope?

Typical applications for borescope inspections include:

- Equipment with high criticality
- Equipment that cannot be easily repaired or replaced
- Equipment that, if a failure occurs, could result in severe harm or injury
- Machines where access is difficult, and inspection opportunities are limited

There are other circumstances, such as diagnosing a failure or looking for contaminants in the bottom of a hydraulic system, where a borescope might also be used.

A typical borescope with accessories for these types of situations might cost upward of twenty thousand dollars. However, some borescopes can cost less than one hundred dollars.

How to Inspect a Dry Dump with a Borescope

With this type of inspection being intrusive, it is essential that the component be de-energized and a LOTO (Lock Out, Tag Out) procedure be performed; this will ensure the safety of the technician and prevent damage to the camera. Once the machine is properly locked out, it is time to locate the best port through which to enter the sump. If you are inspecting gear teeth or a bearing, it might be best to remove the breather port or hatch and enter from the top; this will allow you to inspect more surface area as the camera is sent down. If you want to inspect the bottom of a reservoir, you might enter from a lower port, so you can more effectively scan the bottom portion of the sump. This is a great method to use if a reservoir has just been flushed and you are checking the cleanliness of the bottom of the sump.

How to Inspect a Wet Sump with a Borescope

There are many reasons that you might want to inspect a sump without draining the lubricant first, for instance:

- A large sump that is not feasible to drain for a quick inspection
- A sump that, due to its location, is difficult to drain
- A sump that requires frequent inspections between drain intervals

For most borescopes, a wet inspection isn't as easy as probing into the sump and having a look around, as some camera heads are not fluid-proof. There is a work-around for this, though: a piece of PVC pipe with a polycarbonate window glued to the end will provide a good vehicle to get the camera into the sump without getting it wet.

What to Look for Inside

When inspecting a machine and its components with a borescope, you will be looking for the same signs of wear you would look for if you had taken the machine apart. Below are a few components and what you might look for:

Gears — The great thing about inspecting gears is the amount of surface that can be viewed. Checking the gear teeth can provide a wealth of information pointing to the condition of the gear. Gear teeth should be inspected for any sign of abrasive fatigue and chemical wear. The gear teeth and side surface of the gear need to be inspected for cracking as well; if any cracking is found, it should be measured (if possible) and checked for any growth on the next inspection.

Bearings — With the way elements are positioned in a bearing, there is usually only a small amount of surface area that can be inspected. There are still many things we can inspect, though, such as positioning (to make sure the bearing is still intact), bearing seals and the rolling elements themselves. Rolling elements should be inspected for the same types of wear as a gear, with special attention paid to any type of pitting.

Sumps — It might be a little overwhelming when inspecting tanks and sumps. Because of their size, there can be a lot to look at. A sump's walls should be inspected for varnish and pitting, while the sump floor should be inspected for sludge and any solid contamination that lay on the bottom.

Seals — Confirm that seals are still seated and inspect for any obvious ingression or damage.

Summary

There is a great deal of information we can gather from performing inspections using borescopes without having to disassemble a machine. These inspections can even validate data from another inspection tool such as thermography or oil analysis. With the ability to save pictures and film after each use, borescopes are a great tool for a reliability program. ***ML***

About the Author

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

Wes Cash | Noria Corporation

A New Era **for Reconditioning**

More about this **ASCEND™ Factor**

Factor:
C5K – Contamination Control KPIs

Level:
KPI's (K)

Stage:
Contamination Control & Lubricant Reconditioning

About:
Defining and monitoring key performance indicators can increase the efficacy of contamination control strategies.

Learn More:
noria.com/ascend/

"Lubricants don't go bad; they simply get dirty." This cliché has been shared widely throughout the industry despite being false. Lubricants fail through various mechanisms, including loss of additives and a change of molecular composition of the base oil; this is far more than simply getting dirty. While sayings like these may not be completely correct, the landscape is rapidly changing to where they may be more true than false.

Think about the advances in technology, especially in fighter jets. Each iteration of jet that comes out is more technologically advanced — to the point where a human pilot is less necessary. There will come a time where there is no longer a human inside the jet. The same advancement is happening with industrial lubricants. The question of when will be the last time we change oil in a machine should be considered.

Imagine a lubricant that never fails, never goes bad, and is perpetually operating at its optimum performance and chemical properties. The lubricant no longer needs to be changed; it is simply reconditioned to maintain its properties. This is the future of lubrication.

In the past, reconditioning of lubricants was mostly relegated to a series of decontamination steps for the removal of water and solid particles. The lubricant was cleaned and dried and then put back into service. This practice is still in use today, where the oil is drained from a reservoir into a tote or storage vessel, and a kidney loop system is employed to get the oil to a target cleanliness and dryness state. There is nothing wrong with this practice, but true reconditioning can go much further.

At the core of reconditioning, the overall goal is to get or keep the lubricant in a "like-new" state. This means the lubricant can perform to its original capabilities without any unanticipated hiccups; reaching this state will likely require more effort than simply cleaning the fluid. We have to concern ourselves with additive levels and base oil health when deciding if reconditioning makes sense. So, what parameters should a reconditioning program be measured on?

As with most programs, there would need to be a list of Key Performance Indicators (KPIs) to showcase that the program is responding the way we would intend. Below is a list of five potential KPIs that could be easily tracked for lubricant reconditioning.

Target Cleanliness/ Dryness Compliance

Much like you would track these for an asset, you would want to be able to confirm that during any reconditioning process, an acceptable level of moisture and solid particulate is met. This is a good lagging indicator that your reconditioning tools (filtration, dehydrator, etc.) are working to the level they should. It is also a leading indicator for machine and lubricant health, as solids and moisture are catalytic particles leading to the breakdown of the lubricant and damage to machine surfaces.

Lubricant Performance Compliance

A lubricant's properties aren't static; they change over time as the fluid ages and additive levels drop. Rather than simply monitoring additive levels or fluid properties such as viscosity and acid number, a good reconditioning program would look at the actual performance properties of the lubricant and how they compare to the original, "new" fluid. Simply refreshing an additive package or cleaning the lubricant doesn't mean it will perform like new. Basic tests, such as filterability, demulsibility, air release and foam tendency/stability, offer great insight into whether the performance characteristics of the fluid are compromised or not. Depending on the type of fluid in question, you may add in tests that are more applicable to the in-service environment of the lubricant, such as FZG, 4-ball, etc.

Lubricant Purchases by Type

As is the case for most programs, there has to be a financial reason to justify its existence. Reconditioning can provide savings in many ways, but one of the more immediate hard-cost savings should be in the purchasing of lubricant. However, it's important to point out that not all fluids are suitable for reconditioning, which will be discussed later. The obvious goal is that the lubricant being reconditioned would show a drastic reduction in the purchase of that fluid type. This equates to an immediate cash savings that only grows as the fluid is maintained in optimum operating condition for a much longer period of time, perhaps indefinitely.

Mean Time Between Oil Changes

Longer life of the fluid means fewer oil changes and a longer period of time between these changes. This is a long-term metric but one that serves as the ultimate goal of the program, reducing (if not completely eliminating) the need to do an oil change. Start with a historical trend of time between oil changes or significant top-ups, and then set a goal of at least doubling that length of time. This will also help you gauge what necessary tools and modifications will need to be applied to your system.

- **Lubricant Disposal Costs** — This is the second financial indicator, but one that is tied to many different aspects of the program. Within any oil change, there are a significant number of hidden costs. By tracking the cost of disposal (the volume of used oil reclaimed by an outside group), you will have better insight into how these hidden costs are trending. Outside the normal labor and price per gallon for disposal, you should see a noticeable drop in consumables related to oil changes, as well as ancillary administrative functions such as planning, scheduling, supervising, and definitely the cost of unavailability of the machine while it is being drained and refilled.

There are many benefits to having an oil reconditioning program, but it may not always be feasible or economical to start this process. It does require effort, tools, expertise and the right application to maximize the effect. Much like previous articles that have mentioned the Optimum Reference State (ORS), this is no different. Some machines/lubricants will benefit, while others will not. Below are some factors to consider when determining whether a reconditioning program is right for your asset.

Base Oil Health

If the base oil is damaged, stop right now. Reconditioning likely won't solve any issues and is just a band-aid until the oil can be changed. True reconditioning is a proactive measure that protects the structural integrity of the base oil molecules and the fluid's properties. Waiting too long to start can stymie the efforts to begin with. If the base oil is still healthy, then other considerations exist.

Large Volume

Perhaps the most common variable when looking at any lubrication program advancement is the volume of lubricant the asset holds. The higher the volume and cost per gallon, the better care we should take of the fluid to get the maximum life out of it. For volumes less than 100 gallons, the investment might not make sense unless it can be further justified by criticality or the cost of doing an oil change.

Leakage

When a system leaks fluid, new oil is put in to keep up the level at the appropriate volume. This new oil brings in new additives and serves as a way to refresh the oil in service. If you have a system that is prone to leakage and you are adding a significant volume of new oil each year, starting a leak mitigation program would be a higher priority than reconditioning. If top-ups are rare, then reconditioning can be further evaluated.

Labor

Availability of staff to perform oil changes is becoming a very real problem. As plants continue to operate on leaner staffing, extending oil life and minimizing oil changes begin to look very attractive. One would need to review how much labor is dedicated to oil changes or even available for these activities and estimate any potential savings related to this labor if a reconditioning program is initiated. This can help free up manpower for other initiatives in the plant as well.

Fluid/Additive Package

Some oils will take to reconditioning better than others. Fluids that are heavily additized, like motor oils, do not make great candidates for this type of program. Conversely, low additized fluids, such as turbine oils, would be a great place to start. You would have to evaluate each fluid and determine the feasibility of maintaining an additive level. While it is possible for hydraulics and gear fluids to be reconditioned, you may find that it will not be economical depending on your volume of usage.

It's exciting to think about how far this technology has come and is continuing to go. The benefits of lubricants lasting for a significant amount of time are tremendous, but it does raise some questions. What are the unintended consequences of extended oil life? There are bound to be some things that change within the oil that we are blind to or might not entirely understand. We do know that incredibly small particles build up inside the fluid and are never removed, as they are able to slip through filtration systems. As these particles build up, their surface area in contact with oil increases tremendously. This may lead to a change in the properties of the oil in ways that we haven't seen in the past. Regardless, it is a great thought to ponder: when will be the last time you actually change your oil? ***ML***

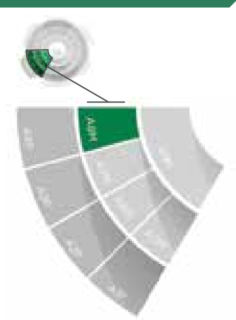
About the Author

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

Paul Farless | Noria Corporation

Playing the Long Game **With Condition Monitoring**

More about this **ASCEND™ Factor**



Factor:
A8M – Troubleshooting and Root Cause Analysis

Level:
Management and Training(M)

Stage:
Condition Monitoring, Lubricant Analysis and Troubleshooting

About:
The overall degree of plant reliability varies in proportion to team education on condition monitoring, lubricant analysis and trouble-shooting topics.

Learn More:
noria.com/ascend/

Often in Machinery Lubrication magazine, there are informative articles about condition monitoring, lubricant analysis, and troubleshooting. However, there has yet to be an article that actually trains the reader. My goal is to provide a brief training guide to condition monitoring inspections for mechanics, lubricators and even some operators. This will serve as more of a reference, or a "how-to," regarding condition monitoring hardware inspections.

Condition Monitoring and Associated Cost

Condition Monitoring is the process of monitoring a parameter of condition in machinery (lubrication, vibration, temperature, etc.) in order to identify a significant change that is indicative of a developing fault. Condition monitoring is a proactive approach to maintenance and lubrication, and we want to stay vigilant with our machinery in order to keep it and our plant operating as smoothly as possible.

Granted, a large part of how well or poorly a plant performs in this area could be due to the nature of what is being manufactured. For example, a cement plant has literal tons of excess dust covering the machinery. It is nearly impossible to keep clean, much less monitor the condition of the lubricant.

Knowing this, I feel as if I need to write a disclaimer: I understand that in these "severely dirty" types of manufacturing, some condition monitoring practices and tasks just can't be completed, simply due to the amount of contaminants and even the product itself nearly burying the machine. It sounds unlikely, but we do see it quite often. What facilities like this should focus on is the machinery that can be saved. If the pump is filled with product, such as asphalt, sealant, corn dust, cement, and sometimes even process fluids, and that material/contaminant is covering sight glasses, vent plugs, or breathers, that pump is just too far gone. I would consider that unsavable, meaning it will cost more personnel hours and money to recover it rather than just replace it and start with a clean slate. When managing a condition monitoring program, the facility needs to spend money to save money, having faith that it will save even more money in the long run. Remember, we're playing the long game; you will not see too many instant large sum savings right out of the gate.

Condition Monitoring Hardware

On the front lines of condition monitoring are the personnel. Humans come with a set of condition monitoring tools: our eyes, nose, ears, and hands. Spending every single day in the plant, you become very in tune with the performance of the machinery via your senses. You know what it normally smells like, the temperature in the area, and the way the machines sound because you hear them every day. When something is out of whack, it should be fairly noticeable. As far as condition monitoring hardware goes, the facility needs to consider a few different factors when setting up hardware modifications

We can start by asking ourselves: Is sampling being done currently, or is it going to start being sampled in the future? Not sampling and don't plan to? A 3D bullseye would work fine and is cheaper than a CMP and hub. Why wouldn't we invest in hardware that brings us closer to our ultimate reliability goal?

Is the equipment considered a "throw and go" or run-to-failure piece of equipment? Most facilities have these small gearboxes; they are lubricated, and they have ports for hardware, but they are just going to be replaced. We aren't necessarily trying to extend the life of this gearbox through condition monitoring practices; it simply isn't worth the trouble and cost of installing hardware.

Inspections

Condition monitoring stripped to its core is trending data of in-depth inspections on the machinery and lubrication. Yes, there is vibration and thermography, among other things, but this is Machinery Lubrication magazine, so we are going to stick with the lubrication side of condition monitoring. As mentioned before, we need to first utilize our senses, so we approach the equipment and methodically inspect the entire train. Remember to take notes, pictures and always record the findings of the inspection. A large part of why we inspect is to trend data over time to track the performance of our machine. With this trending data, we can often predict machine failure before it happens, and we may even be able to prevent it from happening. This is also an excellent way to track the progress of the lubrication program as a whole. A key performance indicator on how well the plant is operating is often found in proactive condition monitoring practices like frequent, thorough inspections.

What to look out for

Just like an emergency situation, as you approach the scene, pay attention to ambient conditions to ensure safety and absolute awareness.

- Is it a hotter day than normal? This can cause an obvious spike in operating temperature.
- Is it more humid? Humidity can have an adverse effect on desiccant breathers.
- Is there any fluid on the deck, skid or ground?
- Has the equipment been exposed to direct water recently, such as rain, nearby steam or spray?
- Are there any differences in smell? Can you detect sulfur, mildew, fuel, etc.?
- Are there any odd noises or excessive vibrations coming from the equipment?

Next, let's take a look at the foundation and mounting hardware for the train.

- Is the foundation cracked? Are there obvious signs that something is wrong?
- Is the mounting hardware firmly in place, not showing threads or signs of backing out or breaking?

Finally, we will inspect the condition of the lubricant and the condition monitoring hardware already on the equipment. I like to inspect from the bottom up, utilizing a good flashlight.

- Check the BS&W bowl, purge the water if necessary. Make sure it isn't leaking from the threads. Check the purge valve for bending or any leaking or cracking.
- If the equipment has a constant level oiler, make sure that it is ¾ full and the oil within is clean.
- Next, we will look at the sight glass. If it is a 2D, write a work order to replace it with a 3D bullseye; this will make inspecting and monitoring much easier.
- Check the sight glass for proper oil level and lubricant condition.
- If it is a columnar level gauge with a tube back to the headspace or breather, check that the oil is at the proper operating level.
- Then inspect the vent tube for drying, cracking or saturation. If the oil is climbing the vent tube, then the machine isn't breathing properly and further troubleshooting needs to be done. Report immediately.
- Check for lubricant contaminants such as particles, wear debris, shiny flakes, etc.
- Check the lubricant color and characteristics. Is it milky, watery, foamy or discolored?
- If the sight glass is stained, replace it.
- Then inspect the breather/vent plug. If a vent plug or particle breather is installed, inspect for any abnormal conditions, i.e., bending, breaking, or obvious saturation, and replace it with a desiccant if applicable.
- If a desiccant, then inspect the media for discoloration and replace if necessary.

Special consideration should be taken when inspecting large circulating systems like reciprocating compressors or hydraulic reservoirs. Take the same "from the ground up" approach.

- Observe the ambient conditions around and near the system.
- Inspect the skid, the reservoir area, and do a quick walk around of the system for safety.
- Especially watch out for leaks and funky smells, as these are highly critical pieces of equipment and could potentially cost millions of dollars to repair.
- Inspect the filter(s) and piping.
- Inspect the sight glasses (many circulating systems have multiple in-line sight glasses). This is an important step — problems with these sight glasses can draw the technician a map leading to potential failures.
- Finally, check the entire reservoir for cracking, any broken or missing mounting hardware, or any other abnormal conditions.

I want to reiterate how important it is to take pictures and notes and then report and record findings. Remember, we are trending this data in order to stay on top of machinery performance. Inspections should be taken very seriously, and they should be performed often. Inspections are easy enough to perform that you can almost inspect equipment while walking through the plant. Including condition monitoring tasks such as inspections in your routes is a great way to get ahead of the curve on your facility's way to a world-class lubrication program. ***ML***

About the Author

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

Kristine Mikulan | Schroeder Industries/HYDAC

Best Practices to Control Varnish in High-Volume Oil-Circulating Systems

"Varnish is an incredibly polar substance that is no longer easily dissolved in the newer base stocks."

In the context of lubricating and hydraulic systems, the term "varnish" is used to refer to gel- or resin-like or solid varnish-like deposits that form in fluid systems.

Varnish causes:

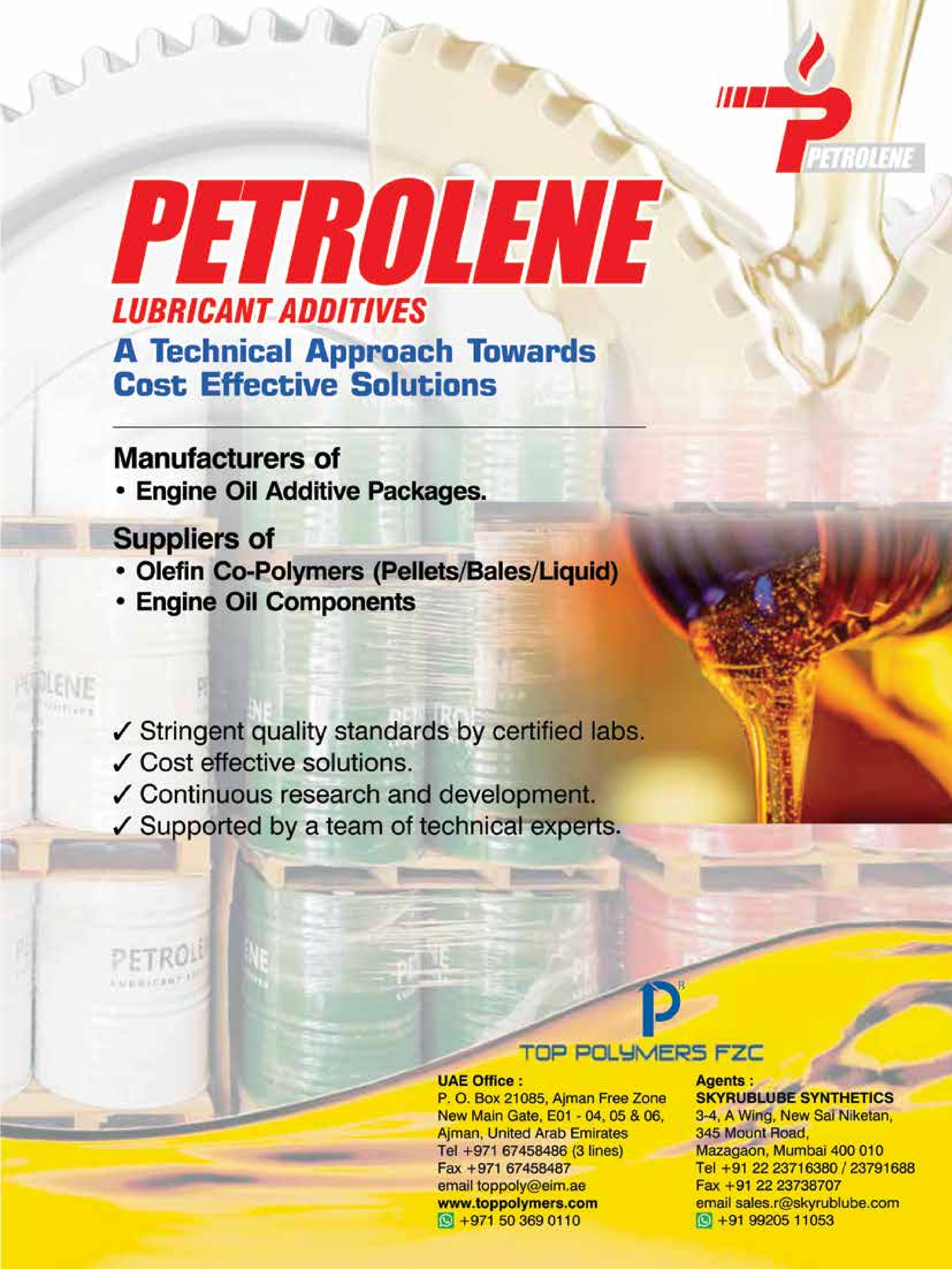
- Elevated turbine bearing temperature due to increased friction in the bearing
- Functional problems with the control valve due to increasing deposits in the gap between the piston and the housing
- Cooling problems due to the varnish impeding heat transfer
- Short filter lifetimes

The cause of these lacquer-like varnish deposits is oil aging and becoming damaged at the molecular level.

In most cases, however, the above malfunctions are not correctly attributed to the real cause. This results in ineffective (and often very expensive) repair work.

Causes of the Increase in Varnish Formation

Today, system operators are confronted with the fact that the base oils used are changing or have already been changed. While in the past, an oil was produced exclusively in crude oil distillation (Group I oils), modern processes are used to reduce the content of substances hazardous to health (e.g., aromatics). The change in the oil production process has resulted in base oils with a lower content of unsaturated/polar hydrocarbons (Groups II, II+, and III). With Group 1 base oils being polar, polar substances were more easily dissolved. The changes in oil production have led to an oil with less polarity; therefore, a reduction of the amount of polar substances that can be dissolved


PETROLENE
PETROLENE
LUBRICANT ADDITIVES
A Technical Approach Towards Cost Effective Solutions
Manufacturers of
• Engine Oil Additive Packages.
Suppliers of
• Olefin Co-Polymers (Pellets/Bales/Liquid)
• Engine Oil Components
✓ Stringent quality standards by certified labs.
✓ Cost effective solutions.
✓ Continuous research and development.
✓ Supported by a team of technical experts.
TOP POLYMERS FZC
UAE Office :
P. O. Box 21085, Ajman Free Zone
New Main Gate, E01 - 04, 05 & 06,
Ajman, United Arab Emirates
Tel +971 67458486 (3 lines)
Fax +971 67458487
email toppoly@eim.ae
www.toppolymers.com
+971 50 369 0110
Agents :
SKYRUBLUBE SYNTHETICS
3-4, A Wing, New Sai Niketan,
345 Mount Road,
Mazagaon, Mumbai 400 010
Tel +91 22 23716380 / 23791688
Fax +91 22 23738707
email sales.r@skyrublube.com
+91 99205 11053

in the oil is now being seen in hydraulic oil systems. Varnish is an incredibly polar substance that is no longer easily dissolved in the newer base stocks.

Polar substances tend to dissolve more readily in polar substances. If the proportion of polar hydrocarbons in the oil is reduced, oil aging products (more commonly referred to as "varnish") cannot dissolve as easily. The effect is oil turbidity or deposits in the system. These changes usually start once the oil has been in operation for 3 to 4 years. As soon as the solubility limit for varnish is exceeded, it precipitates and forms conglomerates, which lead to deposits in the system. Varnish is not heavier than oil and deposits on metal surfaces and at colder locations (tank, cooler, valve body) in the system — not on the tank bottom!

Due to the low proportion of polar substances, these oils also have low electrical conductivity. If this oil flows through the filters in the hydraulic system, an electrostatic charge can be generated. Electrostatic discharge (ESD) occurs in turbine lubrication systems as a result of friction between the fluid and the system components. An indication of ESD is a clearly audible clicking sound as the accumulated charge discharges, causing sparking internally within the system.

Less apparent effects involve movement of the electrical charge downstream of the filter, which produces damage to system components and the filter.

The amount of charge generated by the flow of oil through a filter is related to several fluid and filter properties. The charge generation/accumulation generally increases with increasing flow rates (velocity through the filter element). Reduced fluid conductivity, certain additive packages and lower temperature (higher oil viscosity) can also lead to increased electrostatic charge in the oil.

The subject of oil aging is not new by any means; in fact, it has always been an issue. The characteristics of oils have changed due to the introduction of more highly refined base oils. The hydraulic oils are expected to handle higher temperatures, be more efficient and have reduced levels of hazardous components.

This means that fluid monitoring and fluid conditioning are becoming more and more important.

Today's technical data sheets for oils do not give information on the base oil used. Since oil names are often not changed when the oil type is changed, it may mean the old oils are inadvertently mixed with new, more modern oils during refilling. Such mixing can result

Varnish deposits on hydraulic pump (1), filter element (2) and tank walls (3 & 4)

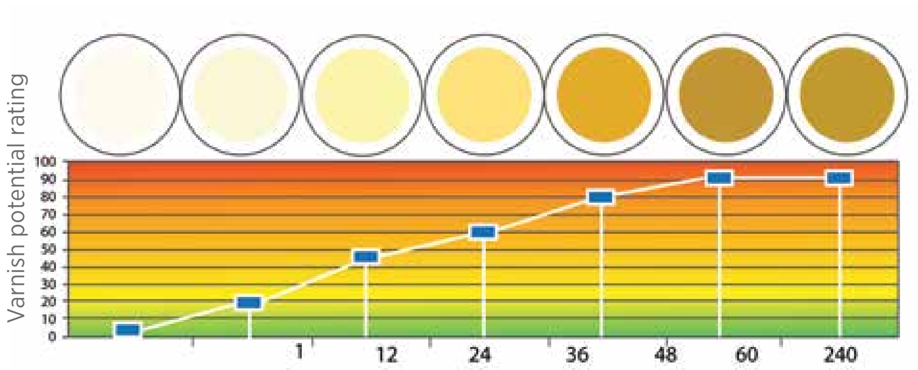
in chemical reactions, which, under certain circumstances, may lead to the precipitation of reaction products and to deposits within the system.

How Do I Recognize Varnish?

The presence of varnish in oil cannot be detected through routine lab analysis. In laboratory reports, varnish is found as a dark precipitate on a filter membrane. This testing is called an MPC (Membrane Patch Colorimetry) which records the changes in the color of a filter membrane with 0.45μm filtration rating. Critical system conditions occur if the MPC value is over 40. The effect is more deposits occurring in the system.

Laboratory particle counting will differ greatly from online measurement using a portable particle counter; for example, a laboratory measurement may give 24/23/17, while an online measurement will be 16/14/10. The reason for this is that the solubility of varnish in the oil depends highly on temperature. When the oil sample is cooled down, the solubility limit in the oil is exceeded. This is mostly counted in the 4- and 6-micron ranges of the ISO code and results in a large difference when compared to the 14-micron code. Normally, there is a difference of up to four codes between 6 and 14 microns. As soon as varnish is present, this difference can be more than five codes in the laboratory particle count at room temperature. This exceedance of the solubility limit is reversible; when the temperature is increased, the varnish goes back into solution.

How Do I Reduce the Formation of Varnish?



The aging rate of the oil can be reduced through oil care measures. These include:

- Offline filtration: limits the growth in particle size.
- Dewatering: minimizes additive reduction due to leaching.
- Degassing: reduces contact with air and therefore with oxygen.
- Avoid electrostatic discharge in the oil and avoid aging due to local temperature spikes and hot spots.
- Monitor the oil temperature balance in order to detect elevated friction in the bearing or overgrowth of the cooler early on.
- Regular oil analysis and tracking of the oil aging help to avoid critical system states such as jammed control valves for the steam control of a turbine and unsafe machine operation.

Systems Used to Reduce the Effects of Varnish

Removal of varnish from system components is a relatively slow process. Oil aging products are initially individual particles less than 0.1 microns in size. As a result, they can pass through the filter at first and initially do not impair the valve function. In the course of further oil aging, or when the oil is cooled down (e.g., during a system shutdown), these particles agglomerate, become larger, and block the valve function and the filter medium.

The varnish removal systems are recommended to be operated over a long period of time or to be installed permanently. The removal of varnish in a system can be sensitive to elevated moisture levels in the fluid and to the presence of high levels of metal wear particles.

Several different technologies can be employed in a hydraulic system for removing varnish. Methods commonly used for the reduction or removal of varnish in a system are:

- Fine filtration
- Electrostatic purification
- Adsorption by a disposable media
- Chemical rinsing or flushing of equipment

The functional principle of offline filtration is that polymerized varnish in the range of 2 microns is removed by means of very fine filtration. An offline filtration system is installed on the hydraulic reservoir for continuous filtration. Using a cooler or chiller prior to a filtration unit to cool the oil allows the varnish precursors to form and be filtered out. The fine filtration will remove the free varnish and is often combined with a purifier or water removal unit.

Electrostatic dissipative (ESD) filter media was introduced to eliminate potential electrostatic charging problems in the filtration of hydrocarbon fluids. Extensive testing in controlled laboratory conditions and on operating equipment in industrial applications has shown this filtration media to eliminate filter damage and significantly lower charge generation compared with the typical glass-fiber filtration medium. Filter elements are made using a special mesh pack structure to reduce the charging of the fluid and are used in filter housings installed inline.

The use of offline filtration and ESD filter media can result in higher operational safety since sparking, oil degradation and the formation of sludge are eliminated. Longer oil service intervals resulting from fine filtration of the oil can lead to significant cost savings through fewer oil changes, filter element changes and system breakdowns.

Varnish mitigation units are designed to remove the soft contamination that are both in suspension and in solution. Typically, they are a simple design that is easy to use on a wide fluid temperature range. The functional principle of the varnish mitigation unit is to accumulate particles in the range of < 1 micron on an active surface of an ion exchanger. The advantage of accumulating even very fine particles is that the solubility of varnish in the oil is improved. As a result, the oil becomes "varnish-hungry," and soft oil aging products that have already been deposited on surfaces in the system are dissolved and absorbed by the oil. The varnish mitigation units don't have any impact on removing any hardened oil aging contaminates that have formed on the surface. The advantage of a varnish mitigation unit is that the structure of the ion exchanger provides a huge separating surface, and the operating costs of the system are reduced.

The chemical cleaning/flushing method is used for removing varnish utilizing cleaning chemicals that are typically circulated through the system to dislodge varnish from components. The chemicals are added to the hydraulic oil to soften and dissolve the insoluble materials. The flushing action suspends the hard deposits in the fluid, which are then removed with the fluid when it is drained from the system. This process is usually performed for several hours or several days, depending on the system size and the extent of the varnish build-up on components. The chemical cleaning method will require the system to be flushed with clean oil to remove any traces of the chemicals and then refilled with new oil before using.

Conclusion and Summary

Varnish is soft particles in the range of < 0.1 microns that form conglomerates and cause gel-like to hard lacquer-like deposits. The change in base oil has contributed to the increase of varnish formation in the oils. The formation of deposits is increased if the temperature drops and deposits are formed at "cold" points in the system or if the pressure increases.

In general, it is harder for more highly refined oils to keep varnish in solution. Identifying these oils is difficult; it is not immediately apparent from the oil data sheet. The consequences of varnish deposits are not usually traced to the altered base oil properties. Expensive and usually ineffective measures are taken, such as performing mechanical cleaning or replacing the oil.

The formation of varnish can be reduced through oil care. Filtration, dewatering, air removal, and degassing extend the oil lifetime. If there is a varnish problem, a varnish mitigation unit can help to remove "free" and "dissolved" varnish and reduce deposits in the system by improving the dissolving behavior in the oil. ***ML***

References

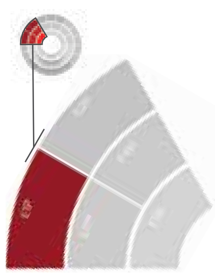
HYDAC International, Sulzbach, Germany HYDAC Technology Corporation, Bethlehem, PA, USA Schroeder Industries, Leetsdale, PA, USA

Bennett Fitch | Noria Corporation

Factor: E1P

Bio-Based Versus Petro-Based Lubricants

More about this **ASCEND™ Factor**



Factor:
E1P — Energy Conservation, Health & Environmental Impact

Level:
Platform (P)

Stage:
Energy Conservation, Health & Environment

About:
Companies should carefully monitor their energy conservation, health & environmental impact as new and used lubricants can cause significant damage when not disposed of responsibly, and every country has different environmental regulations.

Base oils, the primary ingredients in a lubricant, are often first described by their origin, such as those either derived from biological materials (bio-based, such as plants) versus those refined from crude oil (petroleum, or petro-based) from the ground. These two base oil types, along with man-made synthetics, make up the three categories of base oils. Each represents a demand in the lubricant market, and each for good reasons. But there is a lot to understand about the differences between bio-based and petro-based lubricants, in how they are made and where they can be best used. Additionally, bio-based lubricants have numerous terms that are often used interchangeably or in a related context. The infographic to the right helps provide some clarity on these terms.

While the term petro-based is sometimes used, they are more commonly referred to as mineral-based or mineral oils. These are lubricants that are sourced and refined from crude oil. The complex refining process separates the petroleum products that can be used as a base oil from other products, such as fuels, and cleans up the base oil by removing the majority of the impurities. The properties of the original petroleum and the quality of the refining process produce a variety of lubricant characteristics that can be paired up with almost any lubricant application. These represent more than 80% of the world's lubricant market.

On the other hand, a lubricant can be considered bio-based if it is partially or wholly extracted from natural biological sources. They are most commonly from plant seeds but may also come from animal fats or even some forestry products. These are also sometimes referred to as natural esters or natural oils. Whenever bio-based lubricants are identified as a vegetable-based oil, this refers to those from agricultural sources, such as plants. These also are often referred to as veggie oils and plant-based oils. Given their renewable source, they are popular for applications where a renewable product is desired or required. Like mineral oils, they must be refined but are often only marginally altered to help maintain some of their natural qualities, such as biodegradability. Because of their renewable and biodegradable properties, they are often considered environmentally friendly. Bio-based lubricants can further be considered Environmentally Acceptable Lubricants (EALs), based on VGP (Vessel General Permit) regulations provided by the EPA and defined as those which are biodegradable and minimally toxic and are not bioaccumulative.

Biodegradability gives all bio-lubes an important role anywhere the oil in an application has a higher risk of leaking into the environment, while still providing the minimum

Bio-Based Lubricants

QUICK FACTS

Bio-Based Lubricants are at least partially derived from biological material. Also known as **Bio-lubes**.

Not the same as **Food Grade (H1, H3)**, but may be considered this if composed of ingredients defined by CFR 21, Sec. 178.3570.5

Are considered **Renewable** as these are oils produced from renewable sources.

The **USDA BioPreferred Standards** provides certification for bio-based lubricants, even when blended with other base oils like synthetics.

Not the same as **Green Oils (Eco Friendly)**, but may be considered as such if it falls into one of these "green" categories: biodegradable, low eco-toxicity, low bio accumulation, or renewable.

Can be called **Natural Esters** (fats and oils are esters), or sometimes called **Natural Oils**.

Can be used as part of a **Bio-Synthetic** if at least 25% bio-based (renewable) oil and a synthetic oil.

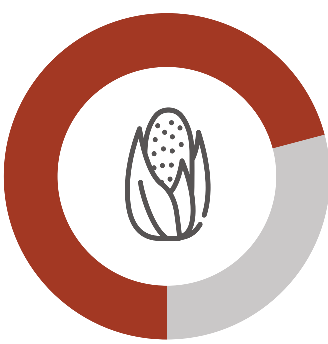
Can be **Environmentally Acceptable Lubricants (EAL)**, lubricants that are biodegradable and minimally toxic.

May be **Biodegradable**, as most bio-based lubricants naturally break down over time. (Ref: ASTM D6064)

3 Types of **Bio-Based Lubricants**

Vegetable-based

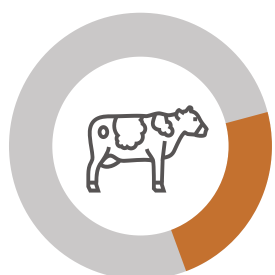
Oils extracted from seeds or other fruit material.



- Canola Oil
- Castor Oil
- Coconut Oil
- Corn Oil
- Cotton Seed Oil
- Crambe Oil
- Jojoba Bean
- Linseed Oil
- Olive Oil
- Palm Oil
- Palm kernel Oil
- Peanut Oil
- Rapeseed Oil
- Rice Bran Oil
- Safflower Oil
- Sunflower Oil
- Soybean Oil

Animal-based

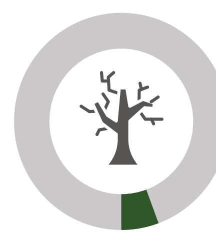
Oils derived from animal fats, predominately made of triglycerides.



- Fish Oil
- Lard
- Milk Fat
- Tallow
- Whale Oil

Forestry-based

Oils derived from tree components.



Did You Know?

In World War II, **jojoba oil** was used to lubricate **machine guns.**

Did You Know?

The U.S. Air Force has used a **beef tallow** jet fuel blend to fuel a **C-17 Globemaster III.**

Did You Know?

The **Statue of Liberty** uses **soy-based hydraulic fluid** to operate the elevator system.

lubrication requirements. This makes bio-based lubricants a desirable option for applications in forestry, automotive, farm, railroad and power transmission for hydraulics, chains, gears, compressors, wire ropes and transformers, to name a few.

Vegetable-based oils are the most common amongst bio-lubes. While these are generally at least 50% more expensive than mineral oil, the benefits do not always favor the equipment's primary lubrication needs. Depending on the sources of a vegetable-based oil, such as soybean, rapeseed, sunflower seeds or castor beans, they each contribute natural benefits, including lubricity, high flash point and high viscosity index. But most vegetable-based oils underperform in important factors like oxidation stability, low-temperature properties or long-term storage stability. This can be partly overcome by formulating with a higher quality sourced product and with more extensive refining processes (chemical modifications) and being properly additized for the application. Most vegetable-based oils rely heavily on antioxidants to delay degradation and hardening over time. Nonetheless, environmental benefits like biodegradability are generally considered a balanced tradeoff to the lubrication benefits like oxidation stability and thermal stability.

While mineral-based and vegetable-based lubricants have significant differences, they both have crucial applications in the industry. The more highly-refined mineral oils are most popular in industrial equipment, largely because of the long-term stability and reasonable price. The hydrocarbon structures of the petroleum product allow for good oxidative stability, thermal stability and suitability for a range of viscosities, making them a go-to choice for general grease applications, gearboxes, pumps, motors and most other industrial machines. Synthetics often provide more improved advantages over mineral oils or vegetable-based oils but come at a higher price. However, as more environmentally friendly lubricants become necessary, the vegetable-based oils will be a likely option. As lubricant manufacturers continue to innovate, we might even see animal-based or other biological sources find their way into the industry as the next leading bio-based lubricants. ***ML***

Acknowledgement to Ben Marquis as a contributing author.

About the Author

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

Vegetable-based Oils	Lubricant Application	Other Consumer Uses
Rapeseed Oil	Chainsaw bar	Biodiesel, cooking
Canola Oil	Hydraulic oil, tractor transmission fluid, metal working fluids, food grade lubes, penetrating oils, chain bar lubes	Biodiesel, detergent, photography, cosmetics, pharmaceutical, ink, paper, textile
Castor Oil	Gear lubricants, greases, hydraulic fluid, brake fluid	Paints, dyes, coatings, inks, cold-resistant plastics, waxes, polishes, nylon, pharmaceuticals, perfumes
Palm Oil	Rolling lubricant-steel industry, grease	
Olive Oil	Automotive	Cooking, cosmetics, pharmaceuticals, soaps, lamp fuel
Jojoba Oil	Grease, lubricant applications	Cosmetics
Crambe Oil	Grease, intermediate chemicals, surfactants	Coatings, plastics, polyesters, nylon, cosmetics
Sunflower Oil	Grease, diesel fuel substitute	Cooking, cosmetics emollient
Cuphea Oil	Motor oil	Cosmetics
Linseed Oil	Cutting fluid	Coatings, paints, lacquers, varnishes, stains
Coconut Oil	Gas engine oil	Cooking, sunscreen, moisturizers
Peanut Oil	Less used	Cooking/frying
Cotton Seed Oil	General use	Cooking
Corn Oil	General use	Industrial cleaner, gas and diesel fuel, cosmetics, liquid soaps, shampoos, cooking

Animal-based Oils and Fats	Lubricant Application	Other Consumer Uses
Fish Oil	Less used	Drying oil, paints, varnishes, lacquers, resins, caulks, sealants, inks, putty, cooking
Tallow	Steam cylinder oil	Soaps, biodiesel, printing, candles, flux
Whale Oil	Watches, delicate instruments,	Soap, tempering steel, dressing for leather
Lard	Cutting oils, sulfurized lard as an additive	Soaps, cooking

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. Oil degradation due to contamination can result in:

a. Viscosity Change
b. Additive Depletion
c. Oxidation
d. All of the Above
e. Only A & B

2. __________ is an oil's ability to separate from water.

a. Demulsibility
b. Flash Point
c. Dryout
d. Crackle Point

3. What type of wear might be caused by air bubbles or water vapor bubbles in a hydraulic fluid?

a. Adhesive Wear
b. Abrasion
c. Cavitation
d. Gouging

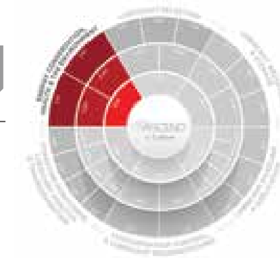
4. Which maintenance strategy is deployed based on equipment condition and focused to eliminate the root causes of failure?

a. Planned Maintenance
b. Proactive Maintenance
c. Predictive Maintenance
d. Planned Corrective Maintenance

5. The units of measurement for kinematic viscosity are:

a. Centistokes (cSt) in mm^2/s -
b. Saybolt Seconds Universal (SSU)
c. Centipoise (cP)
d. Centistokes (cSt) in Pa/s

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



Conserving Energy with These 6 Lubrication Practices

We feel the impact of decreased efficiency in many ways. In our personal lives, it is paying more at the gas pump or seeing a rise in our monthly electric bill. For industrial facilities, this impact is magnified across the total amount of equipment running in the plant. Simple mistakes can result in massive amounts of excess energy consumption and increased wear of mechanical parts. By just modifying a few items and ensuring you are doing the correct things from the beginning, you can be well on your way to recouping some of these costs. **These six items can help you save on your energy costs:**

1 CORRECT VISCOSITY

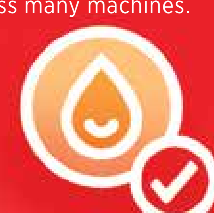
Selecting the wrong viscosity, either too high or too low, can lead to issues and enhance energy costs. Too high, and you will be churning through excess fluid friction; too low, and mechanical friction between machine parts increases. Ideally, we will be at the optimal zone where we have completely separated the operating surfaces but not added a significant strain on the driving part. This is the most common mismatch between a lubricant and a machine: the selection of the wrong viscosity.

2 CORRECT VOLUME

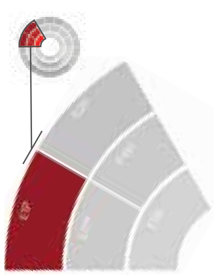
The majority of equipment in industrial facilities are wet sumps and splash-lubricated. Grease-filled components fall into this category as well. When excess lubricant is applied, it creates more material for the machine to move through, which in turn decreases efficiency. This is like walking along the beach in water that is ankle-deep compared to waist-deep; don't waste energy churning through lubricant that isn't needed. Ensure all machines have a way to inspect the proper lubricant level and only regrease components with the appropriate amount rather than purging them.

3 CORRECT BASE OIL

The type of base oil used in the finished lubricant can affect long-term energy savings. Most of the savings are related to how well the molecules of lubricants can slide past each other. With lower refined lubricants, there can be millions of combinations of molecular shapes and sizes, which impacts their ability to move relative to each other. In a highly refined mineral or synthetic oil, on the other hand, the molecules repeat and move more easily past one another. While these savings may be slight, they will add up over time, especially when multiplied across many machines.



More about this ASCEND™ Factor



Factor:
E1P — Energy Conservation, Health & Environmental Impact

Level:
Platform (P)

Stage:
Energy Conservation, Health & Environment

About:
Companies should carefully monitor their energy conservation, health & environmental impact as new and used lubricants can cause significant damage when not disposed of responsibly, and every country has different environmental regulations.

Learn More:
noria.com/ascend/

By making a few adjustments to your current lubrication program, you can ensure that your equipment is running at peak efficiency, all while reducing the energy consumption at your plant.

4 CORRECT ADDITIVES

Additives can help protect surfaces and extend the useful life of a lubricant. When selected properly, they can help minimize friction during start-up, which will save energy on equipment that may start and stop frequently. Lubricants formulated with friction modifiers allow for a slight chemical film to be established at cooler temperatures than traditional wear-control additives; this allows for easier starts and stops, less friction, less wear, and ultimately, savings associated with their use. The use of viscosity index improver additives is also common practice. These additives allow for a temporary "thinning" of the fluid in areas of high flow, so they are more easily pumped than a fluid without them present.

5 CORRECT APPLICATION METHOD

Often considered a lower maintenance function, the tasks surrounding adding lubricants seldom gets scrutinized or reviewed for improvements. Most don't know the proper way to use a grease gun or add oil without putting the machine in jeopardy or making it work harder than it needs to. Lubricants should be added slowly to greased machines when they are running. Slowly pump the grease to minimize churning. Add oils in a manner that won't create significant turbulence in the system that can impact pump efficiency or kick up debris that leads to the wearing of machine parts.

6 CORRECT FREQUENCY

Similar to the previous point, a review of lubrication intervals should be performed to ensure that the application of lubricants is done when needed and not resulting in greatly overextended intervals or the disposal of healthy lubricants. By doing condition-based lubrication, you can ensure that the lubricant is staying in a healthy condition and there is not an unnecessary break in production based upon some calendar date interval that may not be applicable to the system at hand.

About the Author

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

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

Pre-filter New Oil

Adding new oil to a system is a very common practice that can also yield high concentrations of contamination. The industry has no guidelines for new oil cleanliness, which means that it may end up at your facility much dirtier than the oil in your machines. Pre-filtering your new oil before it enters your system is an efficient way of minimizing the particle contamination and reducing the damage those particles will cause. Even opening the system fill port to add new oil is a cause for concern in many plant environments. Adapter manifolds are available that maintain a closed system, even when filtering the oil, for topping up the fluid or draining the tank.

Avoiding Thermal Degradation

Lubricants can thermally degrade for a variety of reasons and causes. Unlike oxidation, thermal failure can occur in new lubricants with healthy additive packages. However, many of the symptoms of oxidation are also symptoms of thermal degradation. One of the most common causes of thermal failure in hydraulic fluids and some lubricating oils relates to aeration, i.e., entrained air bubbles. These bubbles can become rapidly compressed in hydraulic pumps and in the squeeze zones of bearings. This results in extremely high localized temperatures. Hot surface carbonization is another form of thermal failure. When an oil thermally degrades, problems associated with sludge, varnish, deposits, viscosity change and additive decomposition will often occur.

Properly Maintaining Totes

Totes or jumbos are highly susceptible to the entry of dirt or water if not properly maintained. These containers typically contain 400 to 500 gallons of oil or 3,000 to 4,000 pounds of grease and are often used to deliver bulk lubricants to maintenance shops. Most are top-fill units with either a compression ring or break-over hatch with a neoprene or cork sealing gasket and top-mounted air breathers. The seals can become cracked, broken or misaligned, and the air breathers can be easily broken or vibrate loose during transportation and handling. The integrity of the seals and air breathers should be routinely inspected to prevent dust, sand, water and other contaminants from entering the tote during transportation and use. ***ML***


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

Valvoline
ready with lubricant products for EVs as industry expands in India

The 2020-21 fiscal year saw degrowth for several industries owing to the ongoing pandemic but now as markets inch back to normalcy, companies have had to adapt to some new ways of doing business. Plus, the automotive industry is going through a transition in terms of greener forms of powertrain and smarter tech for safety and convenience. Where does the automotive lubricant and additives industry which is a pivotal and rather unsung part of the machinery stand in the midst of these changes? Sandeep Kalia, Managing Director, Valvoline Cummins Pvt. Ltd. spoke about his views recently.

Q. Which segments does Valvoline Cummins attract the most customers from ?

Ans. Valvoline is known as an Original Engine oil brand and has positioned well in the Diesel and Heavy-Duty category. Another factor of our dominance in the heavy-duty category both on road and off road is our association with Cummins which we are very proud of.

As a progressive step for the brand, we have started gaining grounds in the consumer categories as well and the biggest growth pillar is motorcycle oil. We are increasing our foothold in the MCO category, and our current focus is to grow rapidly in the personal engine oil category.

However, the brand will continue to dominate the heavy-duty category because of continuous innovation we have done for the last 20 years and will continue to introduce future ready products as per the technological advancements in the industry.

Q. With the focus shifting to electric vehicles, what changes is Valvoline Cummins preparing for in terms of demand for automotive oils, additives & lubricants?

Ans. The Indian market is still very nascent as compared to Western markets, China, or Europe. Internationally, Valvoline has already launched a complete range of additives, lubricants and even antifreeze coolants for EVs. We have recently launched a full-blown product portfolio in China market. With regards to India, as market grows and demand increases, we will be ready with our products.

Q. Valvoline has had a strong legacy in the automotive lubricants business. How is the company building on this history and what are the expansion plans in India ?

Ans. We are known as the 'Original Enging Oil' because we have been innovating and breaking new grounds to create the finest quality engine oils and lubricants since 1866. From inventing one of the first engine oil about 150 years ago to creating futuristic products such as EV fluids much before the adoption of EVs, we are bu on our history b towards the future.

Valvoline always focuses on introducing new and revolutionary products to improve the quality of commute while keeping the world moving forward. We have emerged as one of the fastest growing brands in the country and our aim is continue that position and be a part of the top three multinational brands in the country .

Overall, we are targeting higher growth than the category average and we are strongly looking at growing at double digit in the personal mobility category.

New product launches taking place in the coming months

We are a dominant player in the automotive lubricant market and launch products much ahead of time. To give you an example, with BS6 engines introduced, there will be new compliances to be followed and Valvoline has already launched CK-4 for the aftermarket, the newest diesel engine oil with all product compliances which can be used for the newest as well as older engines.

We are one of the only companies with DEF in our portfolio which in our portfolio which completes the needs of any truck using BS4 and BS6 Engines. These modern technologies are expected to take over the automotive industry shortly and Valvoline is ready with plans and products

We have BS6 compliant engine oils for not only heavy duty but also for light duty. Also, we are currently working on products for gensets or stationary engines according to the Central Pollution Control Board's newest guidelines-CPCB 4. Under these norms, Stationary engines will require an upgradation, a technology Valvoline is fully aware and ready with the product.

As technologies come and go, we at Valvoline are ready to create and innovate new products which are industry compliant, up-to date and keep the world moving forwards smoothly.

RELIABLEPLANT 2022
CONFERENCE & EXHIBITION

JULY 25-28, 2022

CARIBE ROYALE RESORT
ORLANDO, FL

Join Us In Orlando, FL

Save the date - July 25-28, 2022

RELIABILITY AREAS COVERED

- Change & Sustainability
- Work Management
- Physical Asset Management
- Asset Reliability
- Maintenance Optimization
- Condition Monitoring Strategies
- Data Analytics & Machine Health
- Environmental Health & Safety
- Root Cause Analysis
- Workforce Development
- Leadership & Communication
- Emerging Trends, Practices & Technologies

For more details contact

VAS TRIBO

VAS TRIBOLOGY SOLUTIONS PVT. LTD

Lube & Coolant Management Training Publication Consulting

Email: info@tribologysolutions.com
www.tribologysolutions.com

A comprehensive lubrication services company

LUBE SERV® INDIA

One Stop Shop for all your lubrication hardware and accessories

Our Specialities:

- Lubricant Storage,
- Identification,
- Handling and Dispensing products,
- Desiccant Breathers,
- Visual Oil Analysis,
- Condition Monitoring,
- Lubrication Management.

+91-7004734515
enquiry@lubeservindia.com

Lubrication Hardware & Accessories | Oil Analysis & Interpretation Services