INSIDE

Machinery Lubrication

INDIA May-June 2017

machinerylubricationindia.com

STRATEGIES FOR LUBRICATING BIG IRON

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May-June 2017

Publisher's Note

The latest news that is doing the rounds is that the automobile sector will contribute 12% to India's GDP (Gross Domestic Product) in the next decade. With research facilities being commissioned by the government and steps taken to nurture the sector, we see a great deal of development already set to pace. India's 2 wheeler industry recently became the largest market in the world, replacing China. This growth is also attracting many foreign players into the industry. With the recent entry of Pertonas with the launch of Sprinta, we see major competition uproar. Let us hope to see more lubricant and lubricating solutions in the near future.

With mining activity picking up recently in major parts of the country, it is important to give readers some inputs on how to create lubrication strategies for these heavy mining equipments like large earthmovers such as rope shovels, hydraulic shovels, draglines and bucket wheel excavators. Our cover story – "Strategies for Lubricating "Big Iron"" will not just benefit the heavy vehicles but also the normal-sized machinery to assess the equipment health and tailor a maintenance plan for better life and performance.

Our section on hydraulics had been much appreciated by the readers. In this edition we bring to you "Cavitation or Aeration". Most technicians would confuse between the two but not anymore! The article explains the various symptoms and the underlining differences between the two.

As always, we bring you Lube tips to keep your machinery and equipments in a great condition.

A major conference review is the 3 day conference **Noria's Reliable Plant Conference and Exhibition** at Columbus, Ohio (USA) in which I was a part. This event saw a huge amalgamation of eminent people from the industry. To name a few organizations – Cargil, Chevron, Citgo, Entergy, Honda, Ingredion, Lafarge, Holcim, Michelin and Whirlpool and many more from 40 U.S. states and 28 countries. This indeed is the largest annual event on lubrication & reliability in the world. Throughout the event, great emphasis was given on the holistic approach towards lubricants, lubrication and reliability. The developing nations came together to embrace the idea of machine maintenance by improving the oil analysis regime. Various case studies and learning sessions by - Nissan, General motors, Nestle Purina and Ford Motor Company was a real time experience sharing platform by which many participants benefitted. The exhibit hall showcased a broad range of innovations by Luneta, Y2K Fluid Power, Pall Corp., Whitmore, TestOil, Generation Systems, SPM Instruments and MP Filtri. The keynote speaker, veteran NASA astronaut Dr. Tom Jones shared his valuable 11years of experiences. Overall it was a major learning to see the technological advancements in the field of lubrication technology and an opportunity to make our people aware of them.

Thank you for the overwhelming response on out last edition cover story – "30 years without an oil change" – a case study on extending lubricant life. We have incorporated your valuable suggestions and included various articles in this edition which will be a helpful read.

We thank you all for the valuable feedback and suggestions, which we regularly receive and look forward to your continuing inputs on the quality of content and presentation. We would also like to thank our advertisers for their continued support.

Season's greetings!

Warm regards,
Udey Dhir

JIM FITCH | NORIA CORPORATION

The 5 STATES of Machine INSPECTION 2.0

When most of us refer to inspection, we are thinking of running machines inspected routinely, say on daily rounds. Unarguably, this type of on-the-run inspection is critical to machine condition monitoring, but other types of inspections are important as well. At its best, inspection seeks and finds the "precursors" to failure, also known as root causes. This is job one, for sure. Next, inspection must hunt down those elusive incipient failure conditions (the earliest detectable state) that can be as difficult as the sound of a "pin drop" for our senses to detect.

The time horizon when inspection should incur spans from cradle to grave. I've emphasized in past columns that Inspection 2.0 is a continuous state of vigilance. The moment you let your guard down is exactly the time when the enduring Mr. Murphy makes his entrance. To fend off risk and vulnerability, the wise and reliability-intensive organization performs inspection across multiple states.

Inspection of Spares, Storage and Standby Equipment

Stabilizing spares and standby machinery in a prime, healthy state can be a daunting task, to say the least. Often machines and critical spare parts must be stored for years in a "ready for operation" state. Several articles have been published in Machinery

Lubrication magazine on maintaining idle and standby equipment. This is serious business to protect your investment and more importantly to sustain a state of readiness.

Without a doubt, the central enemy for this type of equipment is water that condenses, settles, puddles and corrodes. Therefore, from the standpoint of inspection, looking for water entry points and the presence of invaded water is high on the list. The ability of a lubricant's additives to suppress corrosion is largely neutralized when additives are unable to circulate. For numerous reasons, water is rightfully the scourge of stored and idle machines and spare parts.

Many types of machines are internally flooded with oil during storage to minimize air movement between the headspace and the atmosphere. This also keeps internal surfaces oil wet, which would otherwise be exposed to condensation and other atmospheric contaminants. In gearboxes, these surfaces would include all bearings, internal shafts and gears. Because of hydrostatic forces, these flooded machines are prone to leakage over time, often through gaskets and lip seals. All evidence of leakage, from dampness to oil puddles, should be noted and corrected.

Also, check to ensure:

- All shafts and couplings have protective coatings still in place
- Lube lines and components are tightly sealed (caps, plugs, etc.), and hatches and covers are battened down
- Reservoirs and sumps are clean and free of water and sludge
- Shafts are being rotated frequently
- Dirt and other debris has not accumulated on exterior surfaces
- Parts and small assemblies are sealed (e.g., plastic sheets/bags) and oriented correctly (i.e., vertical versus horizontal), including hydraulic cylinders, bearings, gearboxes, pumps, etc.
- Storage areas do not expose spare parts, assemblies and stored machines to vibration

Start-up Inspection

It is frequently said that the time a machine is most prone to failure is just after commissioning, major repairs or teardown. These episodes are critical states of change, and change presents risk from the standpoint of machine reliability.

There is also the human element. When operators, mechanics and maintenance workers alter a machine, it is often difficult to precisely return it to the previous operating run state. Any kind of intrusive event, despite all good intensions, presents danger. Before tearing down any machine, there must be a compelling need. Explore all non-intrusive options first.

A great countermeasure to avoid start-up risk is thorough and continuous inspection and condition monitoring. Respect all potential areas of danger. Inspect as many of these hazards as possible until operational stability is restored. These include:

- Temperature (all critical zones, components and surfaces)
- Vibration
- Balance and alignment
- Gauge readings (temperature, pressure, vacuum, flow, speed, proximity, etc.)
- Differential filter pressure
- Magnetic plug collections
- Oil level, color and clarity at all sight glasses
- Leak zones

Don't overlook the need to pull samples frequently and run onsite checks for cleanliness levels and wear debris. Typically, there is no need for a lab to perform these checks. Many different field methods do an adequate job, including patch testing, the Durban method and blotter spot testing.

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Run Inspection

I've covered this subject in the last several Machinery Lubrication articles. Yes, there is a difference between Inspection 2.0 and conventional practices. An enhanced state of reliability demands an enhanced state of operator involvement. It is not just about quickly looking at a machine, but rather it's about examining the machine frequently and intensely with a skilled, probing eye.

For all "bad actor" machines under your care, there is a critical need for Inspection 2.0 vigilance. These are the machines that are pushed beyond their design limits. They are most responsible for business interruption and lost production, as well as for 80 percent of the costs of downtime and repair.

Stop Inspection

Stop inspections allow you to access those hard-to-reach machine conditions and frictional surfaces. Of course, as previously mentioned, you should avoid all unnecessary invasions that can introduce a root cause for failure. That said, you often can safely gain access to gear teeth, sump walls, couplings, shaft seals, bottom sediment and water (BS&W) bowls, magnetic plugs, bearing clearances, etc., for a brief look at the condition. Cameras, including borescopes, may be helpful.

Repair Inspection

Repair and rebuild inspections present a valuable opportunity that too often goes untapped. What a wonderful learning opportunity failure can be. This not only involves what failed and why it failed, but also what else you can observe while you are performing the autopsy. Consider the following:

What are rebuild shops teaching you about the causes of failed electric motors, cylinders, gearboxes, pumps, etc.? Do you receive inspection reports from these rebuild shops on what they find when they open up your failed machines? Do they give you guidance on prevention? If so, how is this knowledge (feedback) used to improve your maintenance practices today?

Do you procrastinate when it comes to performing needed breakdown autopsies? Once operation has been restored to your process or machine, do you fail to investigate the cause of the failure? Does it take three or even four similar failures before action is taken to seek the cause?

Besides the search for failure root causes, do you use the opportunity to inspect other wear zones and machine surfaces? How about used filters, strainers, sump floors, seal condition, corrosion, journal bearings, etc.?

Does your organization have assigned responsibilities for failure reporting, analysis and corrective action system (FRACAS) activities? How about root cause analysis?

One of the problems with repair inspections and failure investigations is that the people assigned to the task are often the same people who are directly or indirectly a target for blame. Asking a maintenance organization to find fault in itself has inherent challenges for which there is no easy solution.

Part of the answer is culture. Building a culture of continuous improvement and not a culture of blame and finger-pointing goes a long way. We all make mistakes. How can we learn from them?

I've detailed the five states of machine Inspection 2.0. How does your reliability organization compare?

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 published more than 200 technical articles, papers and publications. He serves as a U.S. delegate to the ISO tribology and oil analysis working group. Since 2002, 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.

STRATEGIES FOR LUBRICATING

BIG IR

BY BRIAN GROFF, CONTINENTAL PLACER

Typically, when mine operators are asked what they are doing for their lubrication program, the response is generally along the lines of scheduled preventive maintenance (PM) and used oil analysis provided by the equipment manufacturer. Unfortunately, these activities alone do not constitute an effective program. This article will explore lubrication strategies for "big iron," which includes large earthmovers such as rope shovels, hydraulic shovels, draglines and bucket-wheel excavators.

FAILING GEARCASES ON ROPE SHOVELS

A pair of rope shovels working the central Appalachian coal region had planetary gearcases on the propel drives (i.e., the tracks). On average, one of four planetary propel gearcases in service would fail every six to eight months. In a matter of two years, it was conceivable that all four gearboxes would be replaced. A single gearcase cost approximately $400,000, and lead times were increasing to six months. To further complicate the situation, most failures were catastrophic, and the gearcases could not be rebuilt.

So what was causing the gearcases to fail? Lube changes were being conducted approximately every six months on regularly scheduled PMs, and oil samples were being taken nearly every three months, but these tasks alone were not detecting failures. Consequently, there was little belief from the maintenance team that used oil analysis was effective.

Part of the problem was the lack of new oil sample analysis with which to compare the used oil. Lubricants for "big iron" typically have high viscosities (approximately 1,000 centistokes) and unique additive packages. The only way to know if you have lost your additive package in your used oil is to have a new oil reference.

Another problem was the test slate being

performed on used oil at the laboratory. As with most used oil analysis, labs sell a basic test package that costs $15 to $20 per sample. Typically, this includes a 19-element atomic emission spectroscopy (AES) report, a viscosity test and an indication of moisture content, which is usually determined by a normal always flags as exceptionally high at the lab. In addition, the AES test cannot fully account for particles larger than 3 to 8 microns, depending on the instrument used by the lab. "Big iron" machine components are much larger than normal, so the wear debris is larger as well. Simply put, the standard tests didn't see the full picture.

THE SOLUTION

The solution was to develop machine-specific test slates with custom alarm limits. This required a premium used oil analysis package. For the planetary gearcases, new oil samples for a baseline reference were sent to the lab. A test slate was assembled comprised of 21-element AES, viscosity, acid number, moisture by crackle test, oxidation by infrared (IR) and direct read (DR) ferrography (see the table below). The DR test was needed to overcome the particle size limitation with AES. While some labs do not offer the DR test, they can perform a particle quantity (PQ) index, which is a suitable alternative.

A customized test slate for "big iron"

Initially, the sample frequency on the four gearcases was weekly so the data density could be increased and what was "normal" could be identified. The maintenance teams thought this was

WEAR ELEMENTS		NEW OIL REFERENCE	TYPICAL USED OIL
Iron	ppm	13	100-300
Chromium	ppm	0	0-1
Molybdenum	ppm	0	0
Aluminum	ppm	0	0-2
Copper	ppm	0	0-2
Lead	ppm	0	0
Tin	ppm	0	0
Silver	ppm	0	0
Nickel	ppm	0	0
Vanadium	ppm	0	0
Titanium	ppm	0	0-1
Manganese	ppm	0	0
Cadmium	ppm	0	0
Contaminant Elements			
Silicon	ppm	19	0-20
Sodium	ppm	0	0-2
Boron	ppm	1	2
Additive Elements			
Magnesium	ppm	7	6-8
Calcium	ppm	5	6-8
Barium	ppm	0	0
Phosphorus	ppm	185	185-220
Zinc	ppm	2	2-10
Non-Metallic Content			
Water	% vol.	Nil	Nil
Solids	% vol.	<0.1	Not tested
Lube Data			
Viscosity at 40°C	cSt	318.0	Alarm at ±10%
Acid Number	mg KOH/g	0.85	1.2
Infrared			
Hydroxy		N/A	0
Anti-wear Loss		N/A	0-1
Oxidation		N/A	0-11
Nitration		N/A	5
Oxidation/Sulfate		N/A	30
Additional Tests			
PQ Index		9	30-80

A customized test slate for "big iron"

overkill, but buy-in and support were obtained from management.

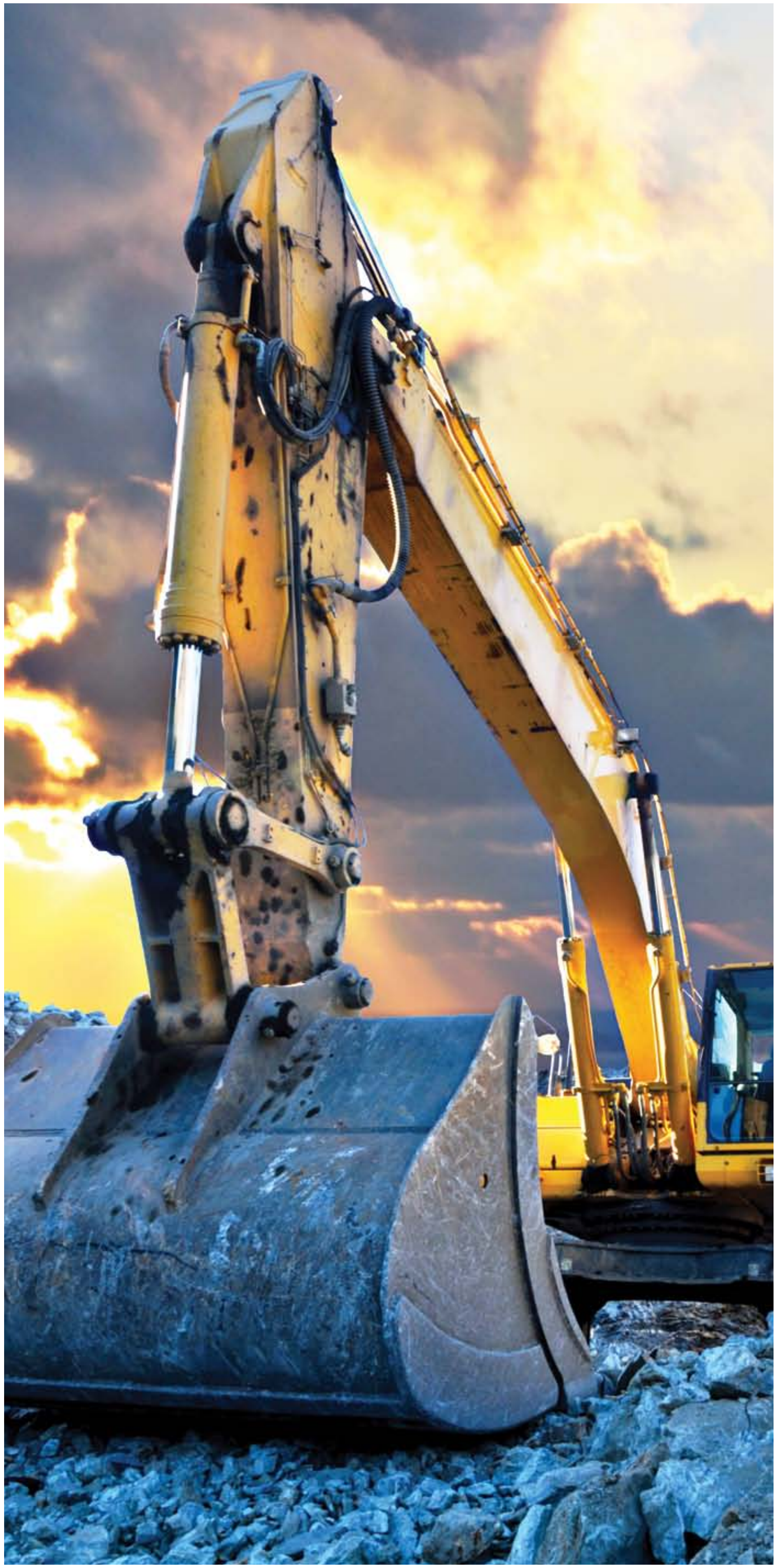
One of the gearcases was new and just put into service. After two weeks of operation, the maintenance crew sampled the gearcase. When the oil analysis report was received, a resample was ordered immediately because the additive levels of the used oil did not appear correct. The resample confirmed that the new oil's additive package had been lost. This is not uncommon for new oil in new machinery. In layman's terms, what happened was that the additives had attached themselves to the machinery's components and were no longer suspended in the oil.

An oil change was ordered on the gearbox, which had been in service only one month. The cost of the oil change was $3,000-$4,000, but the cost of a new gearbox was $400,000. Traditional wisdom for maintaining this machinery was to change the oil approximately every six months. In actuality, it was more like once a year.

As monitoring continued on a bi-monthly basis, the in-service oil was good for three to four months before additives starting dropping out and oxidation levels increased. With custom test slates and close monitoring, used oil analysis was able to determine the proper oil change intervals, and the planetary gearbox failures stopped completely.

COST SAVINGS

Effective maintenance should be viewed in terms of the profits generated. The baseline case for this example involved a gearbox failure every six months, with a cost of $800,000 per year in parts alone. Assuming a gearbox lifespan of five years, the replacement costs



amounted to $320,000 annually for the four units in service. The oil change costs included two changes per year per gearcase at a cost of $3,500 per oil change, for a total of $28,000 annually for the fleet. This was increased to three changes per year per gearcase, for a total cost of $42,000. The cost of the used oil analysis was negligible. So for a $14,000-increase in lubrication costs, a profit of $466,000 per year was generated. The savings could be even greater if the operator only incurred rebuild costs and not replacement costs.

Please note that the oil change interval was dependent upon how much the operator trammed or propelled the shovel. A long-distance tram generally requires an immediate oil change. Effective lubrication programs target and monitor specific failure modes, and there is no standard package applicable to "big iron."

	BASELINE (BUSINESS AS USUAL)	EFFECTIVE LUBRICATION PROGRAM
Cost of new gearcases (per year)	$800,000	$320,000
Cost of oil replacements (per year)	$28,000	$42,000
Total	$828,000	$362,000

Many other practices can also be profitable, such as offline oil filtration, using oil sampling ports, adding desiccant breathers and utilizing magnetic filtration for circulating oil systems often found on draglines and shovels. Whether you have "big iron" or normal-sized machinery, knowing the limitations of the technology used to monitor your asset health and tailoring your maintenance activities to overcome these limitations will be paramount in achieving success.

About the Author

Brian Groff is a senior mining engineer and consultant for Continental Placer, which has been providing services to the mining and industrial minerals community since 1988. Brian has more than 17 years of practical experience in zinc, salt, coal, limestone and aggregates, and has visited more than 100 mines worldwide.

BY AL SMILEY, GPM HYDRAULIC CONSULTING

Cavitation or Aeration?

How to Tell the Difference

Many maintenance technicians confuse cavitation and aeration. In fact, aeration is sometimes referred to as pseudo cavitation. While these two conditions have similar symptoms, their causes are entirely different.

What Is Cavitation?

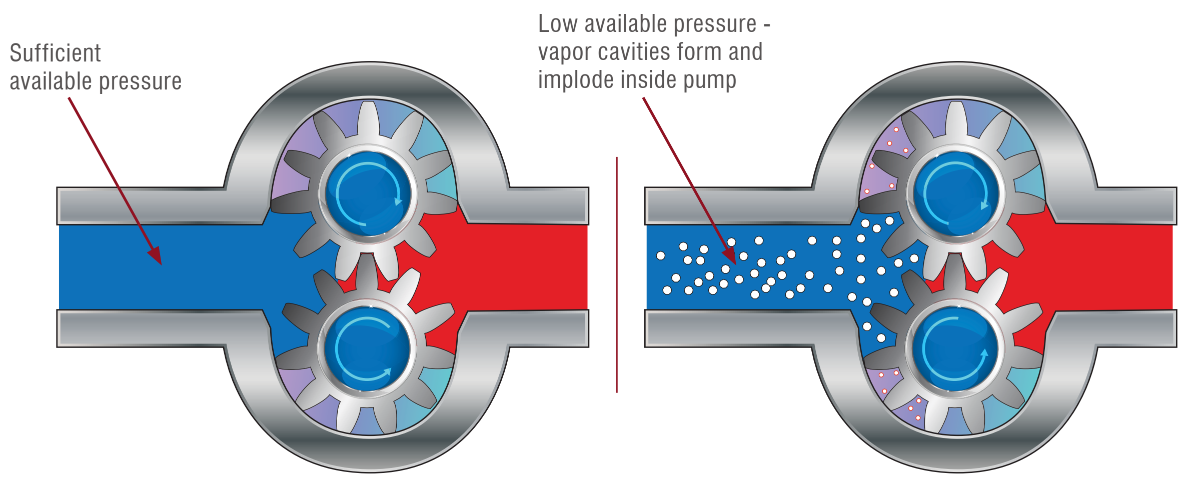
Cavitation is the formation and collapse of air cavities in liquid. When hydraulic fluid is pumped from a reservoir, a low-pressure drop occurs in the suction side of the pump. Despite what many people believe, the fluid is not sucked into the pump but rather pushed into it by atmospheric pressure, as shown in the left illustration below.

The movement of the rotating gears leads to a drop in pressure at the suction line. The resulting pressure difference between the reservoir and the pump inlet causes the fluid to move from the higher pressure to the lower pressure. As long as the pressure difference is sufficient and the flow path is clear, the operation goes smoothly, but anything that reduces the inlet flow can create problems. Whenever the pump cannot get as much fluid as it is trying to deliver, cavitation occurs, as shown in the right illustration above.

Hydraulic oil contains approximately 9 percent dissolved air. When a pump does not get enough oil, air is pulled out of the oil. These air bubbles travel into the pump and eventually collapse and implode when they reach an area of relatively high pressure. The ensuing shock waves produce a steady, high-pitched whining sound and damage to the inside of the pump.

Causes of Cavitation

Any increase in fluid velocity can lead to cavitation. Fluid velocity is inversely proportional to the size of the hydraulic line. Most pumps have a suction line



that is larger than the pressure line. This is to keep inlet velocity low, making it very easy for oil to enter the pump. Any blockage, such as a plugged suction strainer or filter, can result in the pump cavitating. A contaminated suction strainer is the most common cause of cavitation simply because it is underneath the oil level in the reservoir.

One of our consultants was recently called to a plant in Georgia that had changed five pumps on a machine within a week. The first thing that was noticed was a high-pitched whining sound, which was heard every 20 to 30 seconds. The millwrights had changed the suction line, and although a suction strainer was shown on the schematic, none was found in the line. The machine was then shut down, and the reservoir drained to be cleaned. Guess what was found in the reservoir? The suction strainer, which had been floating around in the oil, was occasionally blocking the suction pipe to the pump.

A plugged breather cap is another common cause of cavitation. It can lead to falling pressure in the reservoir. Suction pressure at the pump must drop very low to compensate for this, creating vapor cavities.

At a plywood plant in Oregon, a hose ruptured on the lathe, which resulted in a loss of 150 gallons of oil in the reservoir. After the hose was changed, the lubrication technician removed one of the breather caps to refill the reservoir. While filling the tank, a shift change occurred, and the second-shift lube tech took over. Once the reservoir was refilled, the lube tech installed a pipe plug on the threads where the breather cap was originally located. The result was that one of the pumps on the unit failed within a few hours after startup due to cavitation. After losing two pumps in 24 hours, the pipe plug on the breather opening was discovered.

Extreme oil temperatures can also cause cavitation. High temperatures allow vapor cavities to form with less of a pressure drop, while low temperatures increase the oil's viscosity, making it harder for the oil to get into the pump. Most hydraulic systems should not be started up with the oil any colder than 40 degrees F or put under load until at least 70 degrees F.

In addition, cavitation may result if the drive speed is too high for the pump, as the pump tries to deliver more oil than it can get into its suction port. If the pump is positioned so fluid must be lifted a long way from the reservoir, atmospheric pressure may be insufficient to deliver enough fluid to the pump inlet, which can cavitate.
Systems at high altitudes are also susceptible to cavitation, as the available atmospheric pressure may be insufficient. It is for this reason that aeronautic hydraulics must use pressurized reservoirs.

Understanding Aeration

Aeration occurs whenever outside air enters the suction side of the pump. This produces a sound that is more erratic than that of cavitation. The whining noise may be augmented by a sound similar to marbles or gravel rattling around inside the pump. If the oil in the reservoir is visible, you may see foaming. Air in the oil can lead to sluggish system performance and even damage the pump and other components.

Causes of Aeration

Aeration is often caused by an air leak in the suction line. Pressure in the suction line is below that of atmospheric pressure, so if there's a leak in the suction line, oil won't leak out, but air will leak in. If you suspect an air leak, put oil on all the fittings and connections in the suction line. If the sound of aeration stops briefly, you have found your leak. An ultrasonic gun can also be used to detect leaks.

One of our consultants was asked to diagnose several pump failures on a system at an automotive manufacturing plant. When he arrived at the unit, he heard an erratic high-pitched sound. He also noticed that there were several fittings in the suction line. He had one of the millwrights fill a bottle with oil and squirt it around all the fittings. When oil was applied to one fitting, the pump momentarily quieted down. This fitting had vibrated loose after 12 years on the machine.

A fitting (marked "A") on this hydraulic pump suction line vibrated loose after 12 years, leading to aeration.

A bad shaft seal on a fixed displacement pump is another common cause of aeration. If you suspect a bad shaft seal, spray some shaving cream around the seal. If it is bad, holes in the shaving cream will develop as air enters the pump.

I was once called to a paper mill where foam came out of the log-kicker reservoir shortly after the fixed displacement pump was started. After performing the shaving cream test, I knew the shaft seal was badly worn. Upon further inspection, I found the pump elastomeric coupling was worn, which resulted in wear on the shaft seal.

Improperly tightened or aligned fittings in the suction line can also cause aeration. Check all of the fittings and make sure they are torqued and aligned according to specifications.

Incorrect shaft rotation may not be an issue with all pumps, but some will aerate if they are turned backward. Most pumps have a direction of rotation stamped or located on a sticker on the pump housing. Many times when a pump is rebuilt, this sticker is removed. Always check the part number of the new pump to be installed with the old pump. Often a number or letter will indicate whether it is a right-hand or left-hand rotation. If you are unsure, remove the pump's outlet line and secure it into a container. Never hold this line, as it could be a hazardous situation. Momentarily jog the electric motor. If the pump is rotating in the correct direction, oil will flow out of the outlet port.

Aeration may also result from a low fluid level. The oil level should never drop more than 2 inches above the suction line. If so, a vortex can form, much like when draining a bathtub. This allows air in the suction line, leading to aeration of the pump.

When troubleshooting hydraulic pump issues, make the visual and sound checks first, as these are the easiest to perform. Remember, aeration and cavitation produce different sounds. Usually you can determine the cause of the problem before the first wrench is turned. ■

About the Author

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Best practices for using Oil Analysis in Lubrication Management

By Bill Quesnel, WearCheck Canada

There is no question that an effective oil analysis program lowers maintenance costs on rotating equipment. The trick is knowing how to run an effective oil analysis program. Organizations must be proactive so the solution to an oil-related problem is not always an oil change. The real benefit of oil analysis is using the data to steer you toward solutions to eliminate lubricant issues. This article will describe the best practices for using oil analysis to monitor your lubrication management program.

Getting Started

Are you waiting until you have implemented basic lubrication management strategies before taking those first oil samples because you know the results will be bad? Don't hesitate to start your program. You likely will see many problematic oil samples, but that is no reason to delay sampling. Oil-related problems are opportunities for your lubrication management program. The worse the problem is, the better the opportunity for a cost-effective solution that will translate into big savings for your maintenance budget's bottom line.

Start sampling before you begin making improvements in order to establish baselines on the condition of your lubricants and lubricated equipment within the plant. Additionally, the initial oil analysis results will provide you with direction in terms of the solutions that should be implemented and on which machinery.

What to Look for

When you receive your first oil sample results, you most likely will see a number of abnormal or critical sample reports. The main issues to watch for are water contamination, high levels of oil particulate, improper oil top-ups and poor oil condition.

It is also possible that you will have results showing abnormal or severe wear in some machines. The purpose of establishing a lubrication management program is to maintain proper lubrication to avoid unnecessary wear, so let's assume your reliability team is assessing these reports and has the situation in hand. Instead, we will focus on the oil-related problems, beginning with dirt and water contamination.

Water will show up on your sample report as "water" or "H2O." Are these results abnormal or severe? At this point, you have not set any alarm levels for water contamination, so it is acceptable to use the laboratory defaults for your industry and type of machine. With most rotating equipment, the contamination limit for water will be 0.1 percent water. Limits will range as low as 0.03 percent for turbines and as high as 0.2 percent for gearboxes. Some compressors using certain synthetic oils may go as high as several percent water.

Dirt will appear on a sample report under silicon (Si), along with the other elemental data for wear and additives. If you are sampling machines with oil filtration, the laboratory should perform particle count testing. Ensure that you are purchasing the correct test kits for this type of machinery. Pay attention to the ISO cleanliness code as well as the particle counts by micron size. Abnormal or severe silicon levels and/or particle count results indicate a problem with contamination. Again, the laboratory will be using typical industry limits for silicon and oil cleanliness, which is fine when you are starting your oil analysis program. Typical silicon alarm levels for most equipment are approximately 25 parts per million (ppm). ISO cleanliness codes for filtered systems are generally around 19/17/14.

Whether it is a lubrication and reliability program or a health and wellness program, education is critical to the overall likelihood of a program's success.

1 WATER CONTAMINATION	2 HIGH LEVELS OF OIL PARTICULATE	3 IMPROPER OIL TOP-UP	4 POOR OIL CONDITION
Water (H20): >0.1% Free Water: >0.5% Ferrography: Ferrous Red Oxides (FRo)	Silicon (Si): > 25 ppm ISO Code +2 above target cleanliness Code.	Viscosity: +/- 10% One or more of Boron (B), Barium (Ba), Molybdenum (Mo), Magnesium (Mg), Phosphorous (P), Zinc (Zn): +/- 25%	AN: +1.0 mg/KOH from base RPVOT: >25% of New Oxidation: >0.20 Abs/.1mm

Above are the most common oil-related issues uncovered by oil analysis and their associated general warning limits.

Improper oil top-ups are a bit more difficult to detect, but look for comments about changes in the elemental additive levels (phosphorus, zinc, magnesium, boron, barium, sulfur, etc.) and monitor any changes in oil viscosity that are plus or minus 10 percent from the oil specification. Elemental additive levels can fluctuate as much as 25 percent, so a laboratory will look for other elements that shouldn't be present or the lack of an element that should be present in the oil. Some labs have very sophisticated algorithms that not only compare the used oil to the new baseline but can also determine the fluid type and compare it to the generic fluid type for the oil you have specified. They can then alert you when a different type of fluid is being used. You may want to inquire whether your laboratory has the ability to perform this level of comparison.

The most blatant types of improper oil top-ups or incorrect oil usage are when the viscosity varies drastically from the specification. This would include when you believe you are using an ISO 320 gear oil, but the viscosity is actually 100 centistokes (cSt), indicating a possible top-up with hydraulic, compressor or circulating oil.

For most lubricated plant machinery, the oil condition is monitored using the oil's acid number (AN). When oil oxidizes, it forms acidic degradation products. An increasing AN signifies oil degradation. Once the AN is over the limit for the oil, it is time to schedule an oil change. Large systems like turbines require more advanced testing, such as rotating pressure vessel oxidation testing (RPVOT), water separability, rust properties, foaming characteristics and air release, to determine if the oil is suitable for continued use.

How to Correct Problems

So oil analysis found some issues. Now what? Realize these oil-related problems are opportunities for improvement in your lubrication management program. Most of the suggestions here are low cost and provide a high rate of return on investment. Many of these recommendations can be implemented within a short amount of time and don't require a huge capital investment. The sooner you get started, the sooner you will improve your maintenance budget's bottom line.

Rated desiccant air breathers are the first place to start. Air breathers are an easy-to-implement, low-cost solution for preventing water and particulate from entering lubricated machinery. Air breathers can reduce moisture levels in lubricants even when oil analysis results show 0.2 percent or less water contamination. Desiccant air breathers dry the air that enters the machinery during operation and also dry the headspace in reservoirs, moving moisture out of the oil. The result is drier oil. In addition, these air breathers have a rated micron filter that cleans the air, which leads to cleaner oil.

For very large systems, dry gas blanketing may be an effective option, especially when there is a readily available source of inert gas present (such as in refineries). For instance, feeding dry nitrogen into a turbine reservoir can create a positive pressure that prevents the introduction of contaminants. The dry gas causes moisture to move out of the oil and into the headspace, where it is exhausted externally.

For systems with major water contamination issues (0.5 percent or more water in the oil), a more involved solution will be required. Start by ensuring that all machine hatches and inspection ports are properly sealed. Upgrading the seals may be necessary. To remove water contamination between 0.3 and 2.0 percent on smaller systems (less than 15 gallons of oil), consider using an offline filtration cart outfitted with water adsorption filter media. If there is too much water, you run the risk of spending a lot of money on filter elements. A bit of consultation with your filter cart provider can help you assess the situation. If the water contamination issues are chronic (e.g., leaking cooler) and you have large systems (greater than 100 gallons), you will need some serious equipment, such as a vacuum dehydrator or bypass centrifugal filtration system. In this case, you will be investing $25,000 to $100,000.

Particulate contamination can be easily managed with proper lubrication, drain ports and offline filtration. Purchase an offline filtration cart that best suits your application. Hydraulic filter carts are fairly straightforward and low cost. Gearbox applications require heavy-duty equipment and time spent to ensure that the filter cart has the proper specifications for the application.

The addition of lubrication and drain ports to machinery that will be part of your offline filtration program is essential, as these ports feature quick connections to allow maintenance technicians to easily hook up a filter cart and perform oil top-ups and changes without having to remove fill and drain ports. Additionally, a desiccant breather can be affixed to the lubrication port, further reducing particulate ingression.

Controlling oil top-ups can be managed easily. Start by installing lubrication porting on equipment to make top-ups easier and provide the right kind of dispensing equipment to empower your lubrication technicians to do the job correctly. If you give your maintenance staff the right tools, they will do the job the way you intended.

Oil identification tags should be attached to the lubrication ports. Use colors and/or symbols to identify the lubricant to be used. Dispensing equipment is available in a variety of colors to match. With some basic onsite lubrication education, your lube crew will be armed with the tools and knowledge to do the job right.

If the sample report indicates a poor oil condition (not contamination), you should schedule an oil change when it is convenient. If this will be an expensive oil change (more than $5,000), it may be prudent to invest in advanced oil testing to determine if an oil change is required immediately or whether the task can be put off for three months or more. Unlike contamination, in 99 percent of cases when the oil condition is a problem, you need to change the oil. For a better indication of what is happening with the oil, request membrane patch colorimetry (MPC) testing for varnish potential and linear sweep voltammetry (LSV) tests to determine the exact amounts of antioxidants remaining in the oil.

Monitoring Your Lubrication Program

After implementing these solutions, what should you watch for on your oil sample reports? The moisture and particulate levels should start to come down once you have properly sealed your reservoirs from contamination. Over about six months, these levels will reach their minimum. It is worth noting the change from the baseline samples and to set reasonable targets going forward.

For example, let's say the water level in your gearbox was initially 0.15 percent and the ISO cleanliness code was 22/20/18. Six months after adding desiccant air breathers and an offline filtration cart program, your moisture levels are 0.03 percent and the ISO cleanliness code is 20/18/16. You should inform your laboratory that you want to establish new alarm limits on these gearboxes. Set the ISO cleanliness abnormal alarm at 22/20/18 (two codes above the new average), and the critical alarm at 23/21/19 (three codes above the new target). For moisture, set the abnormal alarm at 0.05 percent and the critical alarm at 0.10 percent. Now when you receive abnormal or critical sample reports based on the water or particulate level, you will know what corrective action to take – change the desiccant air breather and/or run the offline filter cart for several days and resample.

If you implemented oil identification procedures and invested in appropriate dispensing equipment, you should no longer see significant additive changes (more than plus or minus 25 percent) or viscosity changes (more than plus or minus 10 percent) unless the oil condition is also suspect. When you see a dramatic change, ensure any new maintenance personnel are educated about preventing oil mixing and have been trained regarding the use of dispensing equipment. If training is not the issue, you may have an improperly identified oil delivery and should take samples from the suspected totes or barrels.

Gauging Success

If you have been using oil analysis data to track oil-related issues in your plant, subsequent management reports should show a decreasing trend in the water, particulate and incorrect oil usage statistics.

If you have reduced the moisture and particulate levels, then you have increased the mean time between failures (MTBF) for those machines. In the previous example, the gearbox should see an increase of approximately 1.25 times, based on the moisture reduction, and 1.25 times for the particulate reduction, which means more than a 50-percent increase in MTBF. That is significant.

Regarding lubricant mixing, not all incorrect oil top-ups result in lubrication issues. However, in several instances, serious damage can occur. Adding less than 1 percent of an emulsifying oil, which is designed to hold water in suspension, will destroy the demulsibility of an oil formulated to separate from water, i.e., bearing circulating oil, turbine oil, etc. Machines with bronze components should not use common extreme-pressure (EP) additives. Topping up such a machine with an EP gear oil will not only increase the viscosity but also lead to corrosion of any bronze components long after the problem has been detected and the oil has been changed.

An investment in fluid identification, proper dispensing equipment, and most importantly in training and education will drastically reduce the incidence of incorrect oil top-ups. It is more difficult to put numbers on the savings, but any averted catastrophe warrants the improvement.

Next Steps

With these upgrades, you no doubt will have dramatically improved your lubrication program. Typical internal rates of return and net present value over five years are about 150 percent and $500,000 for a lubrication management program in a medium-sized plant.

The next steps will require putting in a plan for capital expenditure. Invest in a world-class lube room complete with an advanced oil storage system, cabinets and lubrication handling carts. Replace the offline filter cart program with permanently mounted filtration systems on critical equipment. Augment your stawndard oil analysis program with an advanced oil monitoring program for critical machines and those with large oil sumps (in excess of 250 gallons).

As you continue to improve the condition of your lubricants, revisit your wear, oil condition and contamination alarm levels and adjust them accordingly. Your initial investment in lubrication management has likely eliminated 80 percent of your oil-related problems. The next 20 percent will take more continuous efforts.

The subsequent steps involve looking for incremental improvement throughout the plant. It will be essential that you continue to educate yourself on lubrication best practices and seek opportunities to enhance your lubrication program. Remember, world class is a moving target, so my advice is to get started now.

Lube-Tips™

THE "LUBE-TIPS" SECTION OF *MACHINERY LUBRICATION* MAGAZINE FEATURES INNOVATIVE ideas submitted by our readers. Additional tips can be found in our Lube-Tips email newsletter. If you have a tip to share, email it to admin@machinerylubricationindia.com. To receive the Lube-Tips newsletter, subscribe now at www.MachineryLubricationIndia.com/page/subscriptions.

A Better Way to Filter Contaminants

When improving fluid cleanliness, it is much easier (and cheaper) to exclude contaminants by ensuring seals, vents and breathers are in good shape rather than to filter out contaminants when they are already inside a component. Use a full-flow spin-oil filter (with an appropriate beta rating) as an air filter. Because the differential pressure across an air filter is lower than across a full-flow oil filter, oil filters are typically more efficient at removing particles from the air than they are from oil.

Check Soap Residue When Switching Greases

When converting from one grease to another, it may be helpful to determine how much soap residue you have resident in bearing housings and estimate how much flushing will be necessary to eliminate the old material. If the amount of old material is low and the residue is soft and pliable, then you may be able to simply increase the relube frequency, perhaps doubling the cycle for a while to flush out the old grease.

Cap Disconnected Hoses During Maintenance

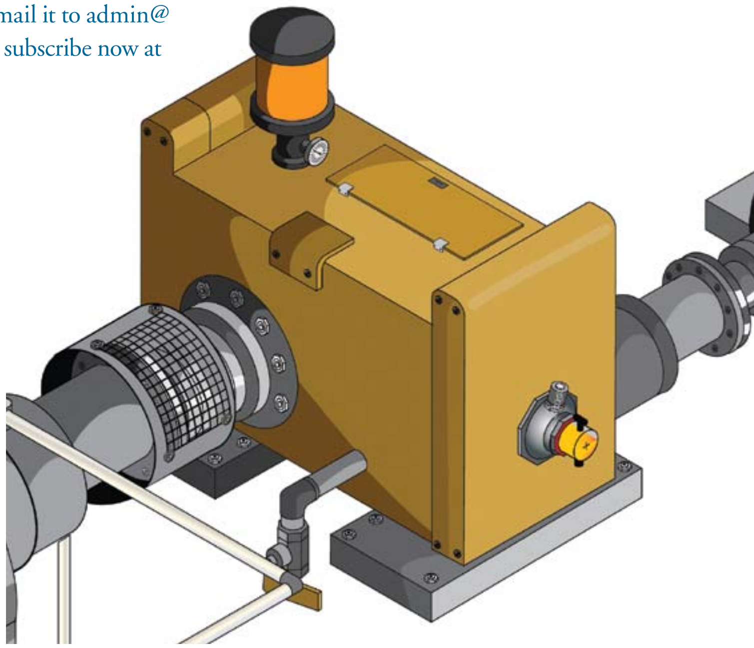
Always ensure that disconnected hoses are capped while maintenance is taking place. It is surprising how much debris can enter an open pipe. This will find its way into the system in short order, causing accelerated wear.

When to Use Silicone Synthetics

Silicone synthetic lubricants are used when resistance to oxidation, heat and/or water is important and the performance of other types of lubricants is unacceptable. Applications include high-temperature grease and the lubrication of oxygen compressors. Negatives for using silicone synthetics include high cost, poor boundary lubrication and poor additive solvency (they don't accept EP and AW additives).

Selecting a Grease to Prevent Corrosion

In a humid environment, condensate can form in rolling-element bearings and cause corrosion, leading to a reduction of the bearing life. By carefully choosing the grease lubricant, you can reduce the effect of the condensed moisture. Greases thickened with sodium soap will absorb (emulsify) large quantities of water but may soften it to such an extent that the grease flows out of the bearing. Lithium soap greases do not emulsify water, but with suitable additives can provide good protection against corrosion. There are also a number of greases available with synthetic thickeners that offer excellent protection against corrosion, prolonging the bearing life.



Advice for Gearbox Oil Changes

When changing oil in a gearbox, I put an air wand (from shop air or portable air source) down into the vent plug. This blows oil residue and deposits off the surface of the gear teeth and casing. It also pushes sediment off the case bottom. I usually hold up a shield to keep the splatter down. Afterward, I like to flush the box with a lower viscosity oil of the same type for a few minutes and then drain again using the air wand. In the past, I used to just drain and fill, but now with this method the oil in the sight glass looks like a new gearbox, with very little residue. The procedure is faster as well.

Why Viscosity Index is Important

As the temperature of a gear oil increases, its ability to support a load decreases. This is due to the thinning effect that temperature has on the viscosity. The rate of change differs for each oil. The rate of change is expressed in an oil's viscosity index (VI) number. The higher the VI number, the lower the rate of change.

If you have a hot gearbox that seems to have a low reliability rating, you might check to see if the oil has a suitable VI and is capable of holding up under the high temperatures. If the product's VI is less than 120, as shown on the product data sheet, then you might consider an alternative oil for the high-temperature, heavily loaded application.

Tips for Repacking Grease Guns

When repacking grease guns from a pressure line, wipe down the fitting and the pressure line to prevent contamination. When repacking with tubes, move to an environmentally controlled area, such as a control room, to replace the tube.

"Is there any way to clean our oil up to two ISO codes other than with loop filtering?"

Best practices recommend that lubricants are filtered when they are transferred from one container to another or to a machine. This practice can improve lubricant cleanliness with just a single pass. The filter must have a high beta ratio (greater than 200) at the right micron size to achieve the expected cleanliness level. Of course, the use of a high-efficiency filter will require the proper lubricant flow rate and pressure according to the viscosity and volume to be filtered.

Installing a temporary online filtration system or "kidney loop" to clean the lubricant in a machine or container is a low-cost option to remove solid contaminants. Since the filtered lubricant returns to the same sump from which it was obtained, it is mixed with non-filtered lubricant. The new sump cleanliness is the result of the mixed concentrations. For this reason, the lubricant must pass through the filter several times. The number of passes will depend on the existing and desired cleanliness level. The lubricant volume will play a factor as well. In the field, it is common to have a lubricant pass through the filter seven times to clean it, but this is just an estimate.

Other alternatives can also be employed to clean the oil, including modern centrifugal technologies. These can be very effective in removing solid contaminants and improving ISO cleanliness codes. They are used for industrial engine oils and frequently applied as a bypass system for the main filtration and lubrication circuit.

Most centrifuge designs utilize the pressure of the fluid going through the system to spin the rotor at speeds high enough to separate contaminant particles from the fluid. In engine applications, the oil is directed to the centrifuge in a bypass loop, which uses from 5 to 15 percent of the pump's flow, depending on the application. This pressurized flow travels through the centrifuge rotor. As it exits the rotor, the oil goes through two small nozzles. The reaction force created by the exiting fluid creates the torque necessary to overcome any friction, and the rotor begins to spin. Typical speeds between 5,000 and 8,000 revolutions per minute can be achieved in most applications.

Other methods such as gravity settling or magnetic filters may not be as effective in removing smaller particles or different materials.

"Is there an oil color standard for oil analysis? We have taken samples of engine lubricants, and some have colors that look like coffee with milk. Is this color acceptable in oil analysis? Do you know the color standard in oil analysis?"

Color can be used as an indicator of oil health, and in many cases it is a reliable field indicator. However, color alone cannot tell the whole story of the oil's condition. For a complete understanding of oil condition, it is important to use an appropriate test slate.

The color of lubricating oils can range from transparent to opaque. The color is based on the crude from which it is made, its viscosity, method and degree of treatment during refining, and the amount and types of additives included.

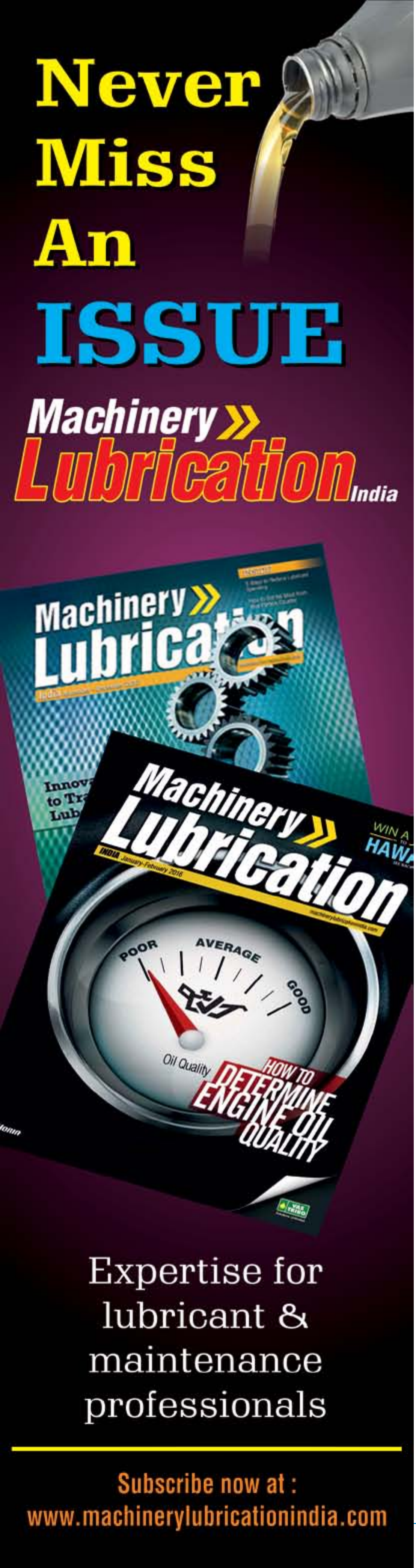
A change in oil color signifies a change in the chemistry of the oil or the presence of contaminants. For example, oil oxidation, mixing two dissimilar types of oil, and carbon insolubles from thermal failure can all darken oil. There is also a possibility that the oil darkening is due to a photochemical reaction from sunlight exposure.

Measuring color is based on a visual comparison of the amount of light transmitted through a defined depth of oil. This can be done with a predefined test method and instrumentation or a subjective view of the oil with reference to a color gauge. In either case, there may be a number of variables to monitor for quality results.

The ASTM D1500-07 test method can be used to compare the color of an oil sample to a glass slide. This test is used in lubricant manufacturing for quality-control purposes. It is performed using a standard light source to match a sample to a glass slide. Values for the glass range from 0.5 to 8.0 in 0.5 increments. If the sample falls between two colors, the higher number is reported. If no color gauge is available, the oil color is compared to a previous sample or a new oil sample.

It should be noted that color is added using dyes in some cases to help identify the type of lubricant, such as red for automatic transmission fluid. Nevertheless, an oil with a specific color should never be assumed to be a certain type of oil. It is also important to remember that there is no particular oil color that would require an oil change.

If you have a question for one of our experts, email it to admin@machinerylubricationindia.com



TEST your KNOWLEDGE

This month, *Machinery Lubrication India* 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.

1. The ISO solid contaminant code:

A) Is a means to characterize the chemical composition of debris found in the lubricant
B) Is useful as a means to accurately state the concentration of dirt in a lubricant
C) Is useful as a means to characterize the concentration of solid particles in a lubricant
D) Is the most useful condition-based measure to gauge oil life
E) Is a means of characterizing the type of solid contaminant

2. Additives:

A) Enhance existing base oil properties
B) Suppress undesirable base oil properties
C) Add new properties that the base oil cannot provide
D) Answers A and B only
E) Answers A, B and C

3. Which two viscosity units are identical: centistokes, centi poise, SUS and mm2/second?

A) Centistokes and centipoise
B) Centistokes and SUS
C) Centistokes and mm2/second
D) Centipoise and mm2/second
E) Centipoise and SUS

Answers

1. C
The ISO solid contaminant code is useful in characterizing the concentration of solid particles in a lubricant. The current ISO solid contamination code provides particle counts for particles larger than 4, 6 and 14 microns.

2. E
Additives are added to base oil to enhance existing properties (examples include antioxidants, corrosion inhibitors, anti-foam and demulsifying agents); suppress existing undesirable properties (pour point depressants and viscosity index improvers are good examples); and add new properties (examples would be EP and AW additives, detergents and metal deactivators).

3. C
A centistoke, which is the unit of kinematic viscosity, is equal to mm2/second. Kinematic viscosity is dynamic viscosity (centipoise) divided by the specific gravity of the fluid. SUS stands for Saybolt Universal Seconds, which is another unit to measure viscosity. The SUS viscosity measurement method has largely been replaced by the kinematic viscosity method.

WES CASH | NORIA CORPORATION

Choose the Right LUBRICANT to Reduce AIR POLLUTION

Lubricants can provide a variety of different functions within a given system. They generally are expected to decrease friction, wear and heat in machine components. One of the more overlooked aspects of a lubricant is its ability to influence environmental emissions. By selecting the proper oil, you can help to reduce some of the harmful contaminants that are spewed into the environment without sacrificing the needs of the machine or the performance of the lubricant.

Emission Factors

When you think of emissions, the first thing that often comes to mind is your personal vehicle's exhaust pipe. These emissions add up over time and have led to laws being passed to limit the idle time of large semi-trucks. Some states even require mandatory testing of vehicle emissions, which is known as smog testing. Much of this has to do with how fuel is consumed during the combustion cycle. The more completely the fuel is burned, the fewer harmful emissions are produced.

Base Oils

While several factors can affect how lubricants impact environmental emissions, let's start by examining the fundamental building block of a finished lubricant, the base oil. A base oil is oil without any additives. Base oils are commonly classified into three categories: mineral, vegetable and synthetic. The majority of the market share is still dominated by mineral base oils, with synthetics rapidly gaining ground. Vegetable oils are increasing in popularity but are mostly relegated to environmentally safe areas, total-loss systems and some food-processing applications. Each base oil has its own strengths and weaknesses, which will determine how much influence it has in controlling emissions.

The Traction Coefficient

One property that can improve a machine's efficiency and lessen energy and fuel consumption is known as the traction coefficient. Consider that if you are able to decrease the amount of force required to move a load across a lubricant film, you can reduce the amount of fuel consumed and the number of emissions produced. The traction coefficient is simply the amount of force required to move a load divided by the load. The closer this ratio is to 1, the more force is required to move the load. As the ratio decreases, the less

By properly matching the needs of your equipment to the properties of the lubricant, you not only can extend the life of your machinery, but you can also help protect the environment.

force is required to move the same load.

Mineral oils by nature have millions of combinations of molecular shapes and sizes in each drop. This inconsistency in molecular size results in a higher traction coefficient. Synthetic base oils are manmade compounds and have much more consistency in several key areas, including their fluid properties and molecular size. This allows a load to move more easily across the lubricant film, thus lessening energy consumption and emissions.

To envision how this works, imagine pushing a sheet of plywood across a series of balls. If the balls are different shapes and sizes (footballs, basketballs, baseballs, etc.), moving the piece of plywood becomes more cumbersome and awkward. Now if you took that same sheet of plywood and pushed it across a series of tennis balls, with each ball the same shape and size, it becomes much easier. This is why most synthetic oils come with claims of reducing energy consumption and can actually help to decrease emissions.

Additives

Aside from base oils, additives are the other fundamental building block of a finished lubricant. Additives are blended into the base oil to impart, suppress or enhance the oil's properties. Depending on the application, varying amounts and types of additives are added to the oil to allow it to better function in the equipment. For instance, turbine oils have a relatively small number of additives, whereas engine oil has a much higher concentration as well as more chemically aggressive additives. To reduce emissions and help your equipment run more efficiently, you should focus on three main additive types: friction-control additives, detergents and dispersants.

Friction-control additives leave a ductile chemical film on machine surfaces to prevent parts from sticking together and to reduce friction between the surfaces when a fluid film is not present. You likely are familiar with two types of these additives called anti-wear (AW) and extreme-pressure (EP) additives. However, a third type, known as friction modifiers, is used in most energy-conserving lubricants. These additives require less activation energy, usually in the form of heat, to become active and work in frictional zones. Simply put, they begin working at colder temperatures than traditional AW and EP additives and thus can further lower energy consumption. In engines, they also can help to decrease emissions.

Detergents serve two purposes: to clean deposits from high heat areas and to neutralize acids formed in the combustion cycle. During combustion, byproducts often get past the rings in an engine and find their way into the oil. These byproducts are referred to as blow-by. If left unchecked, blow-by will produce acids, which can result in shorter oil change intervals and poor lubrication. Detergents neutralize acids before they become a problem, thus extending the oil change interval and diminishing the risk of these acids causing further damage. As is the case with most additives, detergents are sacrificial and have limited lifespans. Typically, once detergent levels drop by 50 percent, the oil must be changed.

Dispersants are used to control soot deposits. Soot is a byproduct of combustion. Over time, soot can build up and lead to a rise in oil viscosity, impaired lubrication, increased wear and shorter oil change intervals. Good dispersancy is key for optimum performance and maximum lifespan from an engine. Dispersants help to prevent soot from agglomerating and settling out of the oil. If soot stays finely divided and suspended throughout the oil, you have a much better chance of filtering it and preventing the associated deposits. This can keep valves and rings free to move, minimizing emissions and acid formation.

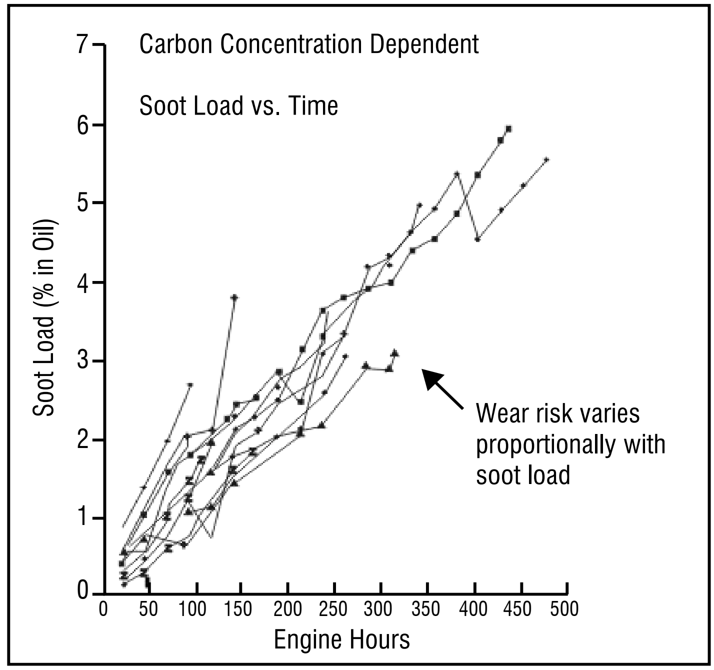
Applications

Possibly the most important application in which emissions can be controlled with proper lubrication is the internal combustion engine. These types of engines are responsible for a large number of emissions into the atmosphere, as most people drive to work or use their vehicle for their livelihood. When purchasing motor oils, you should concern yourself with what is known as the American Petroleum Institute (API) service classification. This classification will tell you if the oil meets the standards put forth by the API in certain aspects, such as additive load, performance, emissions and fuel efficiency. For gasoline engines, the service classification begins with an "S," such as in "SN," which is the current classification. For diesel engines, the service classification starts with a "C," with the most current being "CK-4." There are differences in formulations between the classifications, so it is best to know what your specific engine calls for when purchasing oil for your vehicle.

Another classification found on most engine oils specifically relates to fuel efficiency. On the bottom of the API donut symbol, look for the words "energy conserving" or "resource conserving." When you see these terms, it means this particular oil has passed the ASTM fuel economy test. In this test, oil is introduced to a test engine in which fuel economy is measured. For SAE grades 0W-20 and 5W-20, the candidate oil must show an increase in fuel economy of 2.6 percent after 16 hours of testing and 1.2 percent after 100 hours. For 0W-30 and 5W-30 grades, the candidate oil must show an increase in fuel economy of 1.9 percent after 16 hours and 0.9 percent after 100 hours. The current trend in the automotive industry is to increase fuel economy as much as possible with the use of lighter viscosity grades, better base oils and additive properties that correspond to the engine's needs.

Perhaps the biggest issue plaguing vehicles when it comes to emissions is the formation of nitrogen oxides (NOx). When fuel combusts in an engine with the presence of air, it forms NOx. This is then pushed out the tailpipe and into the atmosphere. There are several problems associated with this, such as a higher

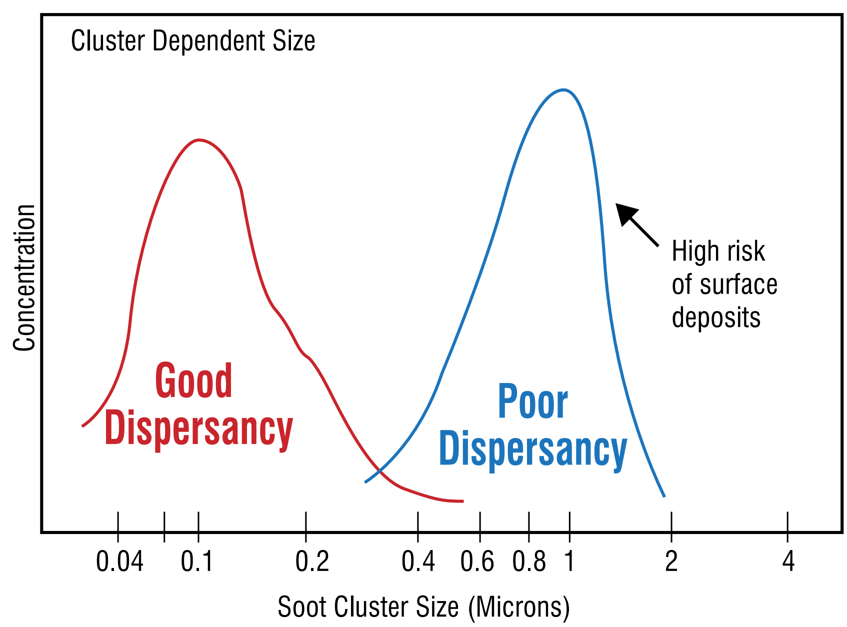
High Soot Load (Causes Wear)



Soot Generation and Load Factors

Combustion Efficiency	Elevation	Fuel economy
EGR	Makeup rate	Drain interval
Idling	Filtration	

Poor Soot Dispersancy (Causes Deposits)



Dispersancy Disruption Factors

High soot load	Fuel in oil
Water in oil	Additive depletion
Antifreeze (glycol) in oil	

50%

of lubrication professionals consider environmental concerns when selecting a lubricant for their equipment, based on a recent survey at MachineryLubrication.com

potential for acid rain and health risks if the compound is breathed in regularly. To combat this, many diesel engine manufacturers have gone to exhaust gas recirculation (EGR) systems.

EGR systems employ the engine oil to further scrub harmful contaminants from the exhaust gases. While this is good for the environment, it can cause trouble for the engine and the engine oil if not properly managed and monitored. EGR systems work by returning some of the exhaust gases back to the engine's intake side. During this time, the gases are cooled, which decreases the flame temperature in the combustion chamber. If the flame temperature is lowered, it helps to reduce the formation of NOx, which is better for the environment.

The problem with EGR systems is the excess soot generated due to the recycling of exhaust gas. Since soot impairs a lubricant's health and increases the risk of engine wear, it is imperative that engines using an EGR system have condition-based oil changes. I've already discussed how vadditives can combat soot and wear, but as the soot load increases, it causes the additives in the oil to be used up more quickly, which results in shorter oil change intervals and a higher risk of failure. In these applications, dispersancy testing is a must.

Although most of this article has focused on engine oils, the same principles can be applied to other applications as well. Compressor systems are another type of equipment that benefits from the proper base oil and additives for better handling of the gases present in the compression chamber and keeping them from being released into the atmosphere. In most refineries and petrochemical plants, compressors are utilized to recycle gases back into the process to be further refined. This cuts down on the venting of gases or flaring (burning off), which leads to environmental pollution.

In conclusion, always keep in mind that by properly matching the needs of your equipment to the properties of the lubricant, you not only can extend the life of your machinery, but you can also help protect the environment in which we live. ■

About the Author

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

BY ALEJANDRO MEZA | NORIA CORPORATION

How LUBRICATION EXCELLENCE Aligns with ISO 55000

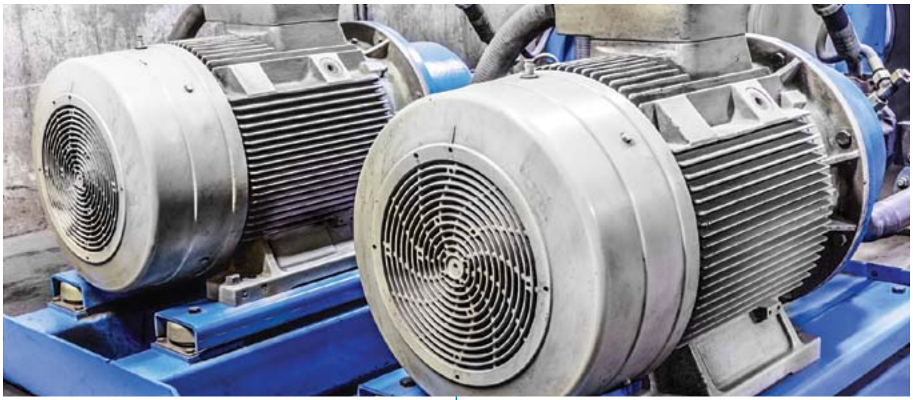
In previous issues of Machinery Lubrication, the asset management standard published by the International Organization for Standardization (ISO) known as ISO 55000 was discussed in regards to how it can provide a framework for supporting the deployment of lubrication excellence. This article will go further by explaining how the requirements for ISO 55000 can be aligned with the features of lubrication excellence to provide a deeper understanding of how a world-class lubrication program can be developed to fulfill these standard requirements, leading to greater machine reliability and eventual ISO certification.

ISO 55000 was released in 2014 with the goal of improving the value realized from an organization's assets. The standard consists of a series of three documents: ISO 55000, ISO 55001 and ISO 55002. The series defines the requirements and guidelines for the effective design, implementation and maintenance of an asset management system. Implementing ISO 55000 can give an organization the confidence that the right things are being done in its asset administration to support the organization's mission and objectives, such as the production of goods and services.

Defining an Asset and Asset Management

According to ISO 55000, "An asset is an item, thing or entity that has potential or actual value to an organization. The period from the creation of an asset to the end of its life is the asset life."

Asset management can be defined as the "coordinated activity of an organization to realize value from assets." It involves the balancing of actions, costs, opportunities and risks related to the desired performance of assets to achieve organizational objectives. In other words, asset management relates to all actions involved in a plant to have productive machines, technologies and systems.



Lubrication Excellence as Part of Asset Management

A good asset management system considers the machine's complete lifespan. In general, the elements of an asset life cycle are as follows:

Comparison of Asset Management and Lubrication Strategies

Note that the stages shown above are interrelated and aligned to other company systems and goals. An asset management system must be supported by strong managerial commitment, organizational culture, training, metrics and continuous improvement. A favorable business environment is another critical factor when

COMPARISON OF ASSET MANAGEMENT AND LUBRICATION STRATEGIES

ASSET LIFE CYCLE STAGE	EXAMPLES OF ASSET MANAGEMENT ACTIONS	EXAMPLES OF LUBRICATION EXCELLENCE ACTIONS
Machine specifications and selection	Machine is selected with the capabilities required for the production (and business) goals as well as the machine's environmental severity and reliability goals.	Selection of online filtration systems, lube room design, lubrication tools and hardware, lubricants and supplier
Installation and commissioning	Adequate practices for transporting and handling of the asset as well as for the installation, alignment, flushing, initial tests and endorsement for operation; modifications and technology for a reliable operation; support systems or hardware that will support a reliable and productive operation as well as good asset maintainability	Lube room implementation, storage and installation of lubricants in machines, installation of filtration systems, machine retrofitting
Operation and maintenance: Operation within the design capabilities is important for a long and productive life. The required maintenance interval is also fundamental. Maintenance strategy is implemented with the best possible resources according to budget and risk. Investment in a reliability strategy is critical for a productive machine life. Maintenance strategy is not static; it should follow a creative and continuous improvement program.	This denotes the machine's or asset's usage and administration during its life. Includes the production/operation program and scheduled shutdowns.The maintenance strategy should include a preventive plan as well as predictive and proactive strategies.Includes technological improvements for production control and machine reliability (continuous improvement).	Development of lubrication program, lube and inspection route scheduling, lubrication-related procedures and tasks, oil analysis strategy, lubricant contamination control program, leak control Periodic review of the lubrication program, use of new technologies, continuous improvement of the oil analysis strategy
End of use	This happens when it is cost effective to replace instead of repair/rebuild. It is also applicable for low-cost components when run-to-fail is the intended maintenance strategy. Assets are set aside, and the asset is unsubscribed from the asset management system.	Lubricants and lubricant-contaminated materials are disposed of properly at the end of their life.

implementing an asset management system.

Lubrication Strategy as Part of ISO 55000 Asset Management

It's easy to see how a well-structured lubrication strategy has a positive impact on nearly every stage of the asset management cycle and how an effective lubrication program can help you achieve your organizational goals. A lubricant could even be considered an asset that contributes to the operational goals.

Keep in mind that the ISO 55000 series of standards do not specify how to do things but rather what should be done. This allows an organization to achieve the requirements by following its internal procedures. Audits can be conducted to compare current practices to the standard asset management requirements. The requisites can then be converted to guidelines for a lubrication strategy so the lube program, tasks and actions can be aligned with the standard.

Following is a brief description of the ISO 55000 series guidelines organized into seven sections: organization, leadership, planning, support, operation, performance evaluation and improvement.

- **Organization** — Asset management objectives must be consistent and aligned to organizational objectives. Stakeholders should be identified and satisfied, and the scope and boundaries of the asset management system defined.

- **Leadership** — Asset management leadership must be put in place by top management. The asset management policy should be defined and reviewed, and the asset management leadership should be

COMPARISON OF ISO 55000 REQUIREMENTS AND LUBRICATION EXCELLENCE PRACTICES

ISO 55000	LUBRICATION EXCELLENCE
Organization The organization's internal and external environment should be suitable for implementation of a formal asset management system.	A lubrication strategy can be implemented successfully when the organization is aware of the opportunities and willing to work in that direction.
Leadership Asset management system implementation and maintenance require top management endorsement and leadership team support. Management defines the asset management system's goals and provides periodic reviews.	Corporate/company lubrication guidelines are prepared. General lubrication program goals are defined. Top management endorsement is obtained. The initial budget is allocated.
Planning Specific objectives must be defined at different levels of the asset management system. Risk assessment is conducted at different system levels.	The risks for different aspects of the lubrication program, including assets, conditions and the environment, are assessed. A formal implementation plan to close gaps is defined. Targets are set at the asset level. Processes are designed, and specific procedures created. The project budget is allocated for implementation and maintenance of the new lubrication program.
Support Necessary resources are allocated, roles and responsibilities are identified, and competencies and performance requirements are defined. There is a formal communication program for the involved team and organization.	Roles, responsibilities and accountability are defined. Job descriptions and competency assessments are required for key personnel (all levels). A training and certification plan is developed. Continuous communication is ensured.
Operation Actions to achieve the specific objectives are implemented. Management is deployed to change processes when necessary.	Lubricants, components and vendors are selected systematically. Lubricant storage practices are improved. The necessary technology and hardware are acquired and implemented. Change management is executed when required.
Performance Evaluation Measure the asset management system at different levels, including assets, external and internal audits, and KPIs.	A system to monitor the lubrication program's effectiveness is implemented. Audits, KPIs, proactive oil analysis and other resources are included in the system.
Improvement Continuously improve the asset management system by establishing new objectives and implementing corrective and preventive actions.	All actions taken are documented as a result of non-conformities. Training, data analysis and improvements to the lubrication program are continued.

given the authority, responsibility and resources to accomplish the identified objectives.

- **Planning** – Risks and opportunities should be identified, and plans put in place to address them to support the achievement of organizational objectives. These integrated plans must address what will be done, when it will be done, by whom, and how it will be undertaken and evaluated. These plans should address risks and opportunities and how they change over time, achieving a balance of risk, cost and performance.

- **Support** – The resources required to accomplish these plans should be made available, along with the information systems to support the process. This information must be documented, controlled, communicated and auditable.

- **Operation** – Plans, implementations and processes should be reviewed and controlled, including any activities that are outsourced or encompass change management. Evidence of the organization carrying out the plans and processes is required.

- **Performance Evaluation** – Asset performance and the effectiveness of the asset management system should be monitored, measured, analyzed, evaluated and auditable. Top management should review the asset management system for suitability, adequacy and effectiveness.

- **Improvement** – Non-conformities or incidents related to the assets, asset management or asset management system must be documented and evaluated, and corrective action taken. Asset management and the asset management system should be continually improved.

With proper interpretation of the standard, a lubrication strategy can be aligned to fulfill these guidelines. It is important to note that there are other ways to fulfill the specific ISO standard requirements, so different approaches than those described above may be accepted during the certification process.

Final Thoughts

ISO 55000 not only applies to production facilities, but it can also be implemented for different asset types in diverse organizations, such as airports, hospitals, offices, etc. It is a good idea to familiarize yourself with these standards, which can be viewed on the ISO or American National Standards Institute (ANSI) websites. For some, ISO 55000 may sound too difficult to achieve, but it can provide an excellent benchmark for goal setting or starting your journey toward improved reliability, especially if your organization wants to be competitive and pursue certification.

As you gain a better understanding of ISO 55000, you will realize the value it offers in implementing a proper asset management system as well as a world-class lubrication strategy that can help you reach your goals.

References

BSI Standards Publication. BS ISO 55000 Series. Asset Management BS ISO 55000:2014, BS ISO 55001:2014 and BS ISO 55002:2014.

Fitch, J.C. (2016). "Will ISO 55000 Change the Definition of Lubrication Excellence?" Machinery Lubrication, Vol. 16, Issue 3.

Cooperleaf White Paper. (2016). "A Best Practice of ISO 55000: Asset Investment Planning and Management."

About the Author

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How to MITIGATE Contaminant Ingression in HYDRAULIC Systems

Hydraulic wiper seals are the first line of defense in many hydraulic systems. Unfortunately, they are also a perpetual problem for most users of hydraulic machinery. Microscopic scratches and gouges on the surface of cylinder rods can significantly reduce the life of wiper seals and give contaminants an easy path into the system. Particles as small as 5 microns can act like sandpaper on these surfaces, causing a chain of wear that grows exponentially in these fine-tolerance systems.

Wiper seals, which are also known as scrapers, excluders or dust seals, are installed on the external side of the cylinder head to prevent dirt, dust, chips and moisture from entering the cylinder/piston rods as they retract into the system. This in turn prevents contamination of the hydraulic oil, which could damage wear rings, seals and other sensitive components.

Wiper Seal Designs

Wiper seals are not created equal, nor should they be, as they must work in many diverse industries. They must also deal with contamination from high-pressure washdowns, exposure to extreme weather and chemical attacks. To survive these conditions, wiper seals are typically made from heavy-duty materials like high-performance polyurethane. In addition, there is the design factor to consider, including the seal's lip and groove geometry.

When the cylinder rod extends past the rod seal, a thin film of oil remains on the rod, trapped in microscopic surface imperfections. The thickness of the oil film will depend on the surface finish, rod seal and surface speed of the rod. During the return stroke, this thin film can be removed by an aggressive wiper lip, resulting in system leakage. Therefore, it is important to properly pair wiper and rod seals. For example, an aggressive wiper lip design requires an aggressive rod seal lip design. If the wiper and rod seal are not matched correctly, leakage and premature failure can occur.

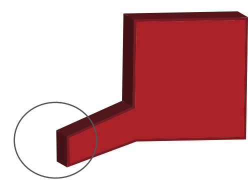

Figure 1. Wiper with single lip

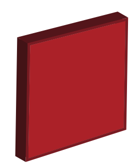

Figure 2. Straight wiper lip

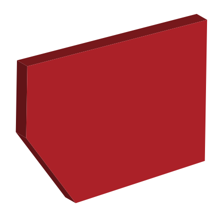

Figure 3. Beveled wiper lip

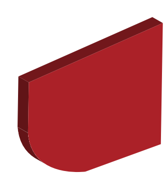

Figure 3. Beveled wiper lip

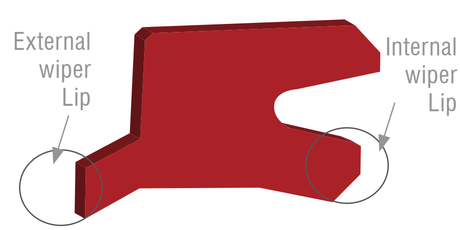

Figure 5. Wiper with double or redundant seal lips

Some of the more common wiper seal designs include single lip, straight lip, beveled lip, rounded lip and double or redundant wiper lips. The single lip and straight wiper lip designs (Figures 1 and 2) are the most aggressive. They offer the best scraping and dirt removal performance, and are recommended for applications with high contamination.

A beveled wiper lip or chamfered lip is less aggressive. The beveled lip allows the microscopically thin oil film on the rod to be retracted back into the system while providing adequate dirt exclusion in less contaminated environments.

The rounded lip is the least aggressive design and is typically used in pneumatic applications to maintain a thin oil or grease film on the rod and keep the piston bearing and seal lubricated.

Double or redundant wiper lips are one of the most effective ways to improve a system's sealing performance. This design must be paired with long-life rod seals. It eliminates the release of built-up fluid pressure between the wiper and rod seal by releasing pressure past the rod seal and into the system.

Hardware Surface Finishes

The cylinder rod's surface finish can severely impact the life of a wiper seal. A mating surface that has scratches, scores, nicks or spiral machining marks can create leak paths and be abrasive to the seal. As a rule, the lower the sealing surface finish, the better the overall seal performance. A lower finish value generally means reduced wear and increased seal life. However, too smooth of a finish will lead to a significant increase in seal wear. Without microscopic peaks and valleys, no lubrication can be retained between the seal lip and the sealing surface. These peaks and valleys are needed to channel lubricant and prevent direct contact that would cause friction and wear.

For polytetrafluoroethylene (PTFE)/Teflon seals, the transfer of a thin film of PTFE from the seal lip to the mating dynamic surface is critical for improved seal life. Dynamic surfaces with relatively rough finishes wear the seal lip material too rapidly. Extremely smooth dynamic surfaces result in material transfer that is insufficient to form a thin film and will lead to an increase in seal wear. The parameters used to describe surface finish are defined in ISO 4287, as shown in the table below.

PARAMETER	DEFINITION (ISO 4287:1997)
Ra	The arithmetic mean of a surface finish profile within a sampling length
Rp	The largest peak height of a surface finish profile within a sampling length measured from the mean line
Rz	The average of the sums of the largest valley depth to the highest peak of a surface finish profile within a sampling length
Rmr (Tp)	The ratio of the material length at a specified depth for a surface finish profile

Bellows/Boots

Many factors must come together for wiper seals to work properly. A good contingency or backup plan for your wiper seals is to use bellows or boots. Bellows offer an effective way to keep contaminants out of your cylinder wiper seals and thus out of the hydraulic system. They exclude contaminants by shrouding the cylinder rod as it moves in and out between the wiper seal and rod seal. This action ensures the full length of the cylinder rod is covered and effectively seals out contaminants like dirt, dust, water and process contaminants.

Bellows can be made of rubber, vulcanized canvas, Gor-Tex, injection-molded polyvinyl chloride (PVC) or fire-resistant fabric. While they are excellent at keeping out contaminants, they can make it difficult to inspect the seals.

Contamination Control

If you suspect your hydraulic system is becoming sluggish and leaking oil past the cylinders, remove a filter and dissect it. Empty the contents onto a white towel and look at it under a microscope. If you have an oil analysis program, check the test results to see if there has been an increase in wear debris and elastomer contamination. If so, a seal may be going bad and the cylinder may be starting to wear.

Before having the culprits repaired, filter the hydraulic oil using an offline filtration system that includes 5-micron filters with a beta ratio of 75-200. While an online filtration system may also work, it would be wise to change the filters before starting. They may already be clogged and just circulating contaminants through the system.

After you have cleaned up the oil and replaced the worn components, consider the cost to change the components as well as the downtime and man-hours involved. If this has happened before, add that to the tally. I'm sure you now have enough justification to outfit your system with bellows, desiccant breathers, quick connects, proper sample ports and sight glass modifications to fully enclose the system and gain the reliability you've only dreamed about.

As with all machinery, hydraulic systems must be inspected periodically. Daily or weekly inspections of your systems and components can save thousands of dollars in repairs and downtime. Remember, it costs much less to do it right the first time than having to fix it afterward. Also, if you don't fix it correctly, the cycle of ingression into the machine will start all over again once you push the start button. ■

About the Author

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RELIABLE PLANT 2017 MAKES ANOTHER SUCCESSFUL STOP IN COLUMBUS, OHIO, USA

The 18th annual Reliable Plant Conference & Exhibition recently welcomed nearly 1,600 industry experts, leaders and decision-makers from around the world to the Greater Columbus Convention Center in Columbus, Ohio, for three days of learning and finding solutions to plant problems. The premier event for lubrication, oil analysis and reliability professionals drew delegates from 40 U.S. states and 28 countries, including groups of individuals from top organizations such as Cargill, Chevron, Citgo, Entergy, Honda, Ingredion, Lafarge Holcim, Michelin and Whirlpool.

CASE STUDIES AND LEARNING SESSIONS

Nearly 100 learning sessions on a variety of topics were available for attendees to choose from. Case-study presentations were given by a number of prominent end users. Mark Beatty from Nissan detailed how the Nissan North America plant in Smyrna, Tennessee, continued its journey to

lubrication excellence after winning the John R. Battle Award from the International Council for Machinery Lubrication (ICML).

"This was a fantastic show. There were lots of technologies and sharing of ideas. It was a great experience."

– Rick Pierce, Roseburg Forest Products

Paul Kimble and Jeremy Jeffers from the GeneralMotors metal stamping plant in Marion, Indiana, described how their facility was able to develop an online vibration program for monitoring its stamping presses, which has resulted in detecting numerous anomalies and saving hundreds of hours of downtime.

Michael Macsisak explained how Nestle Purina was able to successfully implement predictive maintenance (PdM) at its plant in Allentown, Pennsylvania, including how the organization developed its PdM program and kept it moving forward, which PdM tools were the most effective, and how PdM helped the plant add to its bottom line.

> “It’s a great opportunity to learn easy things you can do to get that low-hanging fruit and improve your programs.”
>
> *- Christopher Brokopp, Weyerhaeuser*

Ford Motor Company’s Gordon Van Dusen and William Harmych revealed how Ford performs root cause analysis for its equipment failures using a team approach.

NEW TECHNOLOGIES, PRODUCTS AND SOLUTIONS IN THE EXHIBIT HALL

The exhibit hall featured 120 industry-leading companies and organizations showcasing a broad range of services and solutions. Many innovative products were also unveiled at the event, including new offerings from Luneta, Y2K Fluid Power, Pall Corp., Whitmore, TestOil, Generation Systems, SPM Instruments and MP Filtri. Reliable Plant attendees also were granted access to the exhibit floor of the Precision Machining Technology Show (PMTS). This international gathering of manufacturing professionals included more than 280 exhibitors displaying equipment, products and services to more than 6,000 attendees.

OPENING GENERAL SESSION AND KEYNOTE

In the opening general session, veteran NASA astronaut Dr. Tom Jones gave a stellar keynote address on teamwork and leadership lessons from the astronaut corps. Having spent more than 11 years with NASA, flying on four space-shuttle missions, and working and living in space for 53 days, Dr. Jones recounted the good and the bad from NASA’s half-century-long experience in human spaceflight, from the terrible loss of the Apollo 1 crew and the triumph of the first moon landing less than three years later to the daring repair of the Hubble telescope and the preventable losses of two space-shuttle orbiters and crews.

Attendees even had the opportunity to meet Dr. Jones and have him autograph two of his space and aviation books in the exhibit hall immediately following the keynote address.

2018 REGISTRATIONS NOW AVAILABLE

Preparations are already underway for next year’s Reliable Plant Conference & Exhibition, scheduled for **April 17-19, 2018, in Indianapolis, USA.** New case studies, learning sessions, certificate programs, workshops and an exhibit hall full of the latest technologies will be showcased once again. Registration is now open for Reliable Plant 2018, so don’t miss your chance to take advantage of the bottom-line results that attending this event has to offer. Visit **Conference.ReliablePlant.com** or write to us at **admin@machinerylubricationindia.com** to register your team today.