July - August 2020

Machinery Lubrication

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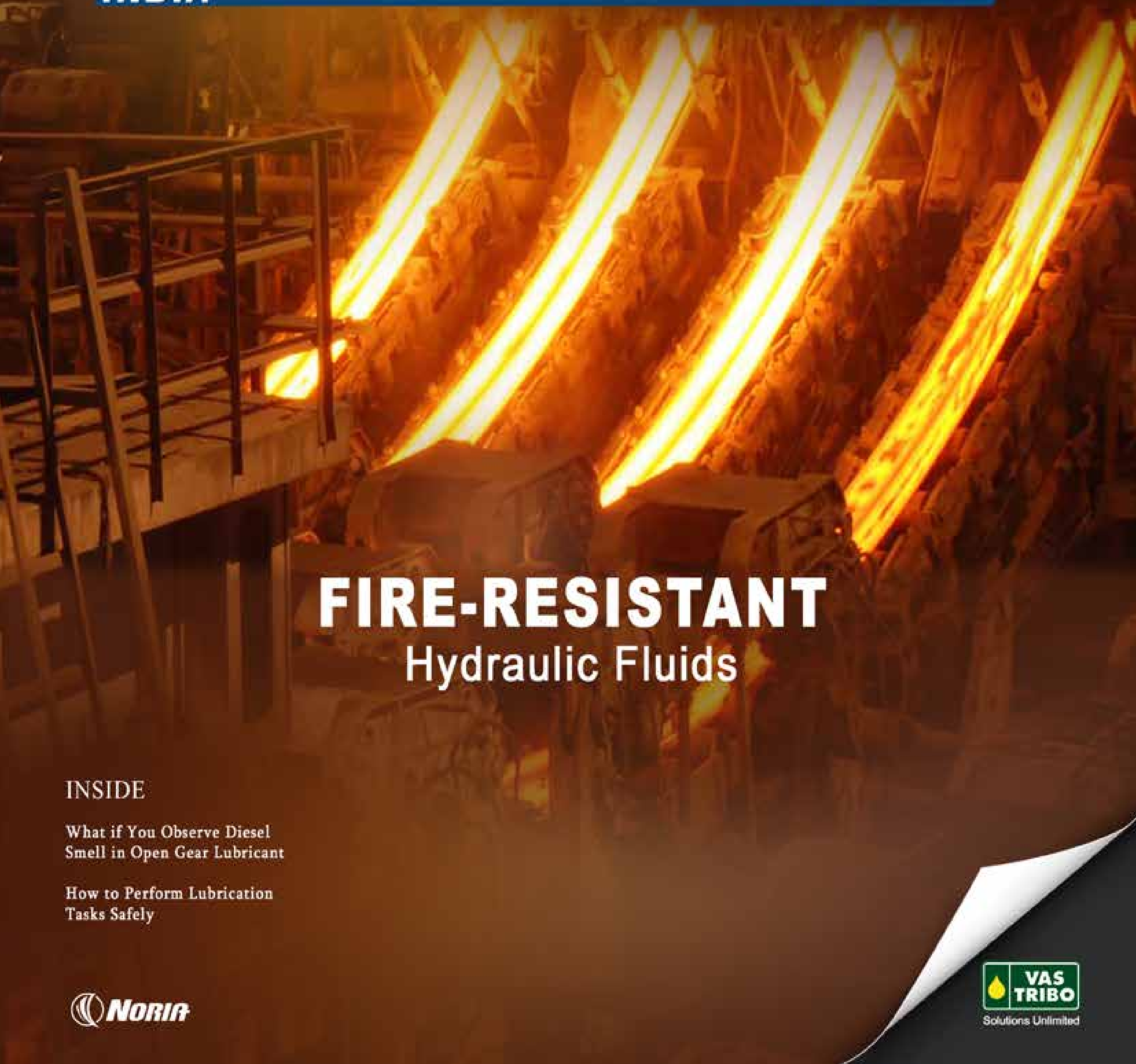

FIRE-RESISTANT
Hydraulic Fluids

INSIDE

What if You Observe Diesel Smell in Open Gear Lubricant

How to Perform Lubrication Tasks Safely

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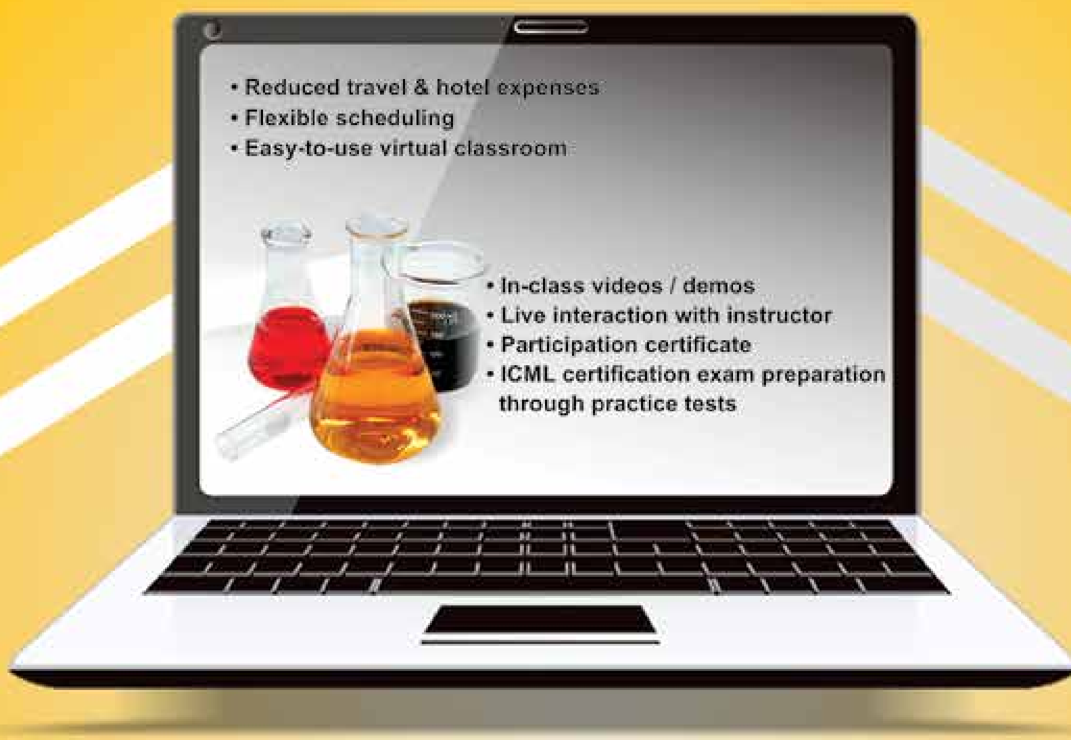

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Publisher's Note

Fire-resistant fluids are most often associated with hydraulic systems. In some of these systems, components must operate at an extremely high temperature, which means you will want to use a fluid that does not ignite easily in the event of a leak. This helps to reduce risk and ensure the safety of plant personnel.

One of the first parameters to consider when assessing the need for a fire-resistant fluid is the operating temperature. This temperature will determine the degree of fire protection required from the fluid in operation. Many lubricants can withstand elevated temperatures, but when you exceed 93.3 degrees C, your options become limited. This is when a fire-resistance fluid may be used.

The fluid's flash point and fire point are critical properties to review when selecting a lubricant for a high-temperature area. Both of these properties provide insight into how well the lubricant can resist combustion or fire at elevated temperatures. The flash point is the temperature at which enough lighter hydrocarbon molecules have evaporated and will ignite. At the flash point, the vapors ignite, but the bulk fluid does not, so the fire is not sustained. The fire point is the temperature at which combustion occurs and fire is sustained. The fire point normally is several degrees (50+) higher than the flash point.

It is important to note that just because a lubricant can withstand elevated temperatures without igniting doesn't mean it will be able to survive for an indefinite period at those temperatures. For this, you must look at the lubricant's oxidative stability. This property is commonly reported by the lubricant's rotating pressure vessel oxidation test (RPVOT) value, which gives an indication of how well the fluid will resist oxidation.

Fire-resistant fluids truly make their mark when a leak occurs in a high-temperature area. Hydraulic hoses and piping may fatigue and crack, allowing lubricant to spray out of them. This can cause a fire in a short amount of time. Utilizing a fire-resistant fluid will greatly lower this risk and may even reduce the need for a fire-suppression system.

While fire-resistant fluids can come with a higher price tag, they often make up for it in safety considerations. By selecting the proper fluid, you can ensure safe operation of your equipment without sacrificing the necessary lubricating properties.

We would like to thank our readers for the great response to our previous edition's cover story – "COVID-19: Lessons from Lockdown".

Our current issue's cover story is "Fire-resistant Hydraulic Fluids" which will help our readers to understand how to manage fire risks without jeopardizing production and know the alternatives to mineral-based hydraulic fluids in steel plants.

You will find many more interesting & useful articles in this edition.

As always, we welcome your feedback & suggestions.

Stay Safe & Be Healthy.

Warm regards

Udey Dhir

5 Ways to Monetize **Lubrication Excellence Now**

"As the quality of lubrication sharply improves, so do the economic benefits. Everything hinges on action and change."

For most organizations, the opportunities for a substantial financial win from lubrication excellence are enormous with lots of low-hanging fruit. The most common financial benefit is reduced downtime by averting high-downtime machine failures. This strategy reveals the "hidden plant" and deploys proactive maintenance (root cause elimination) and predictive maintenance (early fault detection). And, sometimes you need a crisis to focus on reliability.

The problem with the hidden plant is that it requires spending dollars today to mitigate or prevent a future failure event. Yes, a dollar invested today may return $100 dollars or more in the future, but how long must one wait for the return? How certain are you that such an averted failure would have occurred?

For example, if you apply enhanced contamination control to just one machine, say a diesel engine, you might not see a benefit of an extended overhaul interval for more than a couple years. Conversely, if you have a fleet of diesel engines, the total number of overhauls (and lost production) might be reduced by 50 percent in any given time period including the current year.

Still, there are other tangible financial benefits that don't relate to averted future failures. How can the cost of implementing a world-class lubrication program be paid for in today's budgetary cycle? This

is the theme of this article. Also, see Joe Anderson's "How to Show the Value of a Lubrication Program" article on page 27.

Reducing Current Maintenance Costs

See the chart in Figure 1. The green bars represent a typical maintenance budget. Note only 3 percent of the budget is the cost of lubricants. If today's maintenance budget is to be reduced (to save money), the corresponding need for maintenance expenditures must be eliminated.

The challenge is knowing what must be done to reduce the need for replacement parts (new and rebuilt), maintenance labor, supplies and lubricants. What wise and proven maintenance strategy achieves this objective? How much must be invested?

When it comes to precision or optimized lubrication, there is a need for change and often a modest investment. Done right, the results will not disappoint, a fact proven by many documented case studies. These cost reductions are represented by the orange bars in the chart. The magnitude of the benefit is proportional to how dire the current state of lubrication happens to be. The worse things are, the greater the opportunity. It also relates to how well-chosen and executed the optimized solution.

Figure 2 shows this cause-and-effect in a more visual graphic. Failure to invest in change and enhanced lubrication puts the maintenance organization in a cycle of despair (left on the graphic). As the quality of lubrication sharply improves, so do the economic benefits. Everything hinges on action and change.

Cost-avoidance Outside the Maintenance Budget

Some organizations become so accustomed to routine operational costs that they don't recognize the low-hanging fruit in front of their eyes. A good example is poor energy management practices like what occurs in many aging homes today. Poor insulation, air drafts around doors and windows, out-of-date heating and air-conditioning units, etc., all add up to huge financial losses over time. In the typical plant, there are many similar examples. Most are tangible (affecting today's bottom line), and a few less so (more difficult to quantify). By focusing on what's tangible, the cost of lubrication-enabled reliability effectively becomes self-funded and easier to approve by company decision-makers. Following is a list of potential savings outside the maintenance budget:

- Operator idleness due to avoidable scheduled or unscheduled downtime (intangible)
- Lost or slowed production (tangible)
- Energy/fuel consumption costs (tangible)
- Product defects/spoilage (tangible)
- Leakage, waste and disposal costs (tangible)
- Over-budget overtime and other unplanned labor/contractor costs (tangible)
- Over-budget parts costs (tangible)
- Over-budget "rush" part shipping costs (tangible)
- Disruption of purchasing (intangible)
- Disruption of storeroom (intangible)
- Damage to staff morale (intangible)
- Loss of customer goodwill (intangible)
- Safety consequences (tangible and intangible)
- Environmental consequences (tangible and intangible)

The following itemizes ways to monetize a lubrication transformation without the need to avert a future failure event. In other words, it becomes a break-even business proposition within today's budget cycle. Afterward, it's all gravy.

1. Reducing Your Fuel and Energy Bill

One of a lubricant's main functions is to reduce friction. This is achieved through lubricant selection and the method of lubrication. Even small differences in the choice and use of lubricants can have a huge impact on energy consumption. Based on what we've observed, this fact is not intuitive to most users and hence often missed.

Machinery Lubrication India

Publisher
Udey Dhir - udeydhir@tribologysolutions.com

Creative Director
smassociates@gmail.com

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

Advertisement Sales
(India/all other countries)
admin@machinerylubricationindia.com

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

Operation office :

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

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

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Precision Viscosity

When it comes to energy economy, viscosity can be both an inhibitor and an enabler. The oil film produced by a lubricant is directly influenced by viscosity. However, too much viscosity causes churning losses (internal oil friction) and heat production, especially in engines, gears, bearings and hydraulics. It can also result in starvation.

Energy consumption is mostly influenced by the time-weighted average viscosity of the lubricant during the machine's service life. Keep in mind the ISO viscosity grade system is based on 50-percent increments from one grade to the next. From the standpoint of energy consumption, the best choice often lies somewhere in between. Even then, precision viscosity selection can be achieved.

Precision Boundary Film-Strength Properties

Some lubricants gain film strength (reduction of contact friction and wear) from intrinsic properties of the base oil, especially certain synthetics. Other lubricants rely on additives such as friction modifiers, anti-wear and extreme-pressure agents, solid lubricants and fatty acids. The effectiveness of these additives in reducing wear, friction and energy consumption can fluctuate considerably between the different additive types employed. The performance of these additives also varies by machine and application. Good lubrication engineering is needed to find the optimum solution.

Grease Consistency

The consistency of grease can have an impact on energy consumption in ways similar to viscosity. The energy needed to move grease in frictional zones and in adjacent cavities by moving machine elements is affected by the lubricant's consistency and chemistry.

Grease-Channeling Properties

A grease with good channeling characteristics helps keep the bulk lubricant away from moving elements, avoiding excessive churning and drag losses.

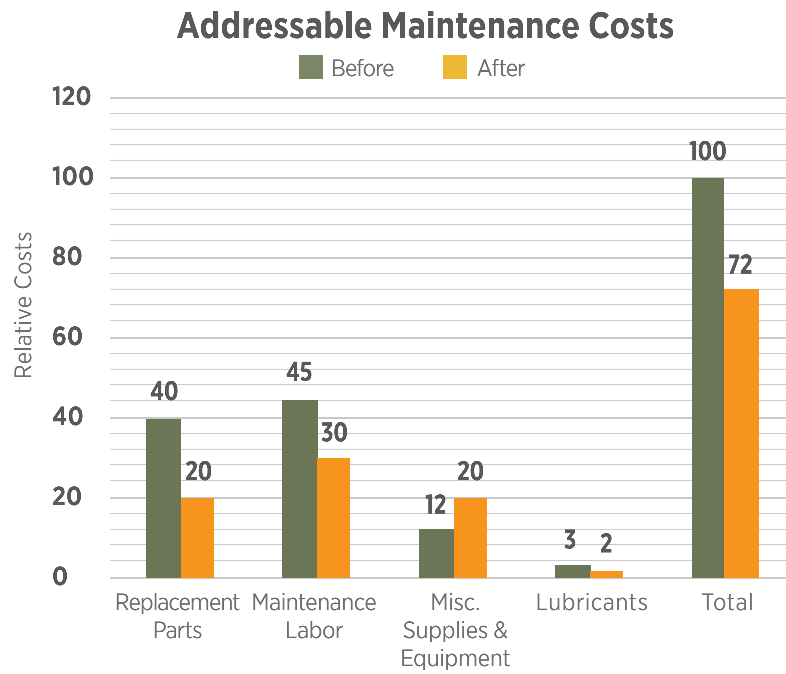

Figure 1. Reducing maintenance costs through enhanced lubrication

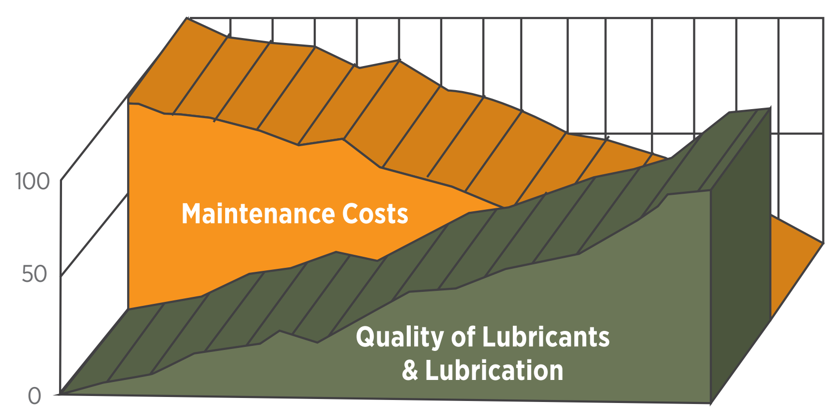

Figure 2. The impact of quality lubrication on maintenance costs

Effect of Contamination

One study discovered that particle contamination can increase fluid temperature by as much as 8 degrees C (due to increased friction). Increased cleanliness of crankcase oils has been found to reduce fuel consumption in diesel engines by 1 to 4 percent or more.

Too Much Lubricant

Overgreasing bearings is known to increase frictional losses and raise bearing temperature. The same is true for bearings that are underlubricated. For bath-lubricated bearings and splash-lubricated gears, a change in oil level by as little as one-half inch (1.3 centimeters) can increase temperature by more than 10 degrees C. This, of course, translates to greater energy consumption, shorter oil life and increased wear.

Air Robs Energy

Excessively aerated oils due to worn seals and wrong oil levels can have similar effects. Studies have also shown the negative effects of overextended oil change intervals on fuel economy in diesel engines. Deferred filter changes cause excessive flow resistance and fluid bypass.

	GEAR OIL	HYDRAULIC FLUID	TURBINE OIL	MOTOR OIL	TOTAL
Current Annual Spending	$70,000	$120,000	$180,000	$40,000	$410,000
1. Precision Optimum-life Lubricant Selection	-$15,000	-$5,000	-$21,000	-$4,000	-$45,000
2. Proactive Lubricant Life Extension	-$13,000	-$3,000	-$12,000	-$3,000	-$31,000
3. Optimizing the Relube Interval	-$6,000	-$15,000	0	-$5,000	-$26,000
4. Reducing Package Waste	-$1,200	-$2,200	0	0	-$3,400
5. Reducing Leakage	-$500	-$22,000	0	0	-$22,500
Optimized Annual Spending	$34,300	$75,800	$147,000	$28,000	$285,100
Percent Cost Reduction	51%	37%	18%	30%	30%
Annual Savings	$35,700	$44,200	$33,000	$12,000	**$124,900**

Figure 3. Example of the potential for reducing lubricant consumption and annual lubricant spending

Oil Mist

In the right application, there can be significant energy savings from total-loss lubricant delivery technologies such as oil mist and centralized lubrication systems. The amount of fluid that a machine uses to lubricate frictional surfaces at any moment is extremely small compared to the amount of fluid some machines must keep in continuous motion.

Wear Causes Energy Losses

Wear not only leads to machine operational failure but also impedes performance in the intervening period leading up to repair or overhaul. During this period, there usually is impaired productivity (efficiency) due to sluggish or erratic machine function, as well as increased energy consumption.

For instance, when hydraulic pumps and actuators wear, they lose volumetric efficiency. This slows work and increases the consumption of energy (and heat distress to the lubricant). Gears and bearings also consume more energy as a result of wear.

Even diesel engines suffer from decreasing combustion efficiency due to wear in the valve train, bottom-end bearings and combustion chambers (rings, pistons, cylinder walls, etc.). A corresponding increase in fuel consumption results.

2. Reducing Your Annual Lubricant Spend

As previously mentioned, lubricant procurement is not the largest expenditure in a typical maintenance budget. However, it is viewed as a real, tangible expense that is frequently targeted for cost reduction. Of course, it is unwise to pretend to save money by "buying cheap." Because lubricants are the lifeblood of your machines, optimum reliability and lubrication must go hand in hand.

Following are six effective strategies for reducing your annual lubricant spend.

Precision Optimum-life Lubricant Selection

Optimum means optimum. Don't overspend and most definitely don't underspend. Resist the lure of cheap oil. Attempting to save money by buying economy-formulated lubricants for the wrong application is hazardous. Likewise, don't be trapped by the false promise of forgiveness. It is equally hazardous to attempt to remedy bad lubrication practices by buying expensive premium lubricants.

Beware of small differences. Selecting the optimum lubricant for a machine application is an engineering process. Small differences in lubricant performance can translate into huge differences in machine reliability and lubricant cost. The critical role lubricant selection has on energy economy has already been discussed.

Being conservative with the number of lubricants in your plant is wise. Reduce the

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LUBRICATION'S ROI

The Institute of Mechanical Engineers reports that lubrication represents a 1-to-40 return on investment (ROI). In other words, each $1,000 spent on improving lubricants and lubrication yields savings of $40,000.

Source: The Institute of Mechanical Engineers (IMECHE). "Wage War on Wear," Tribology Action Handbook. From Shell LubePlanner.

number of lubricants in your storeroom to a comfortable and efficient few. The number and range of lubricants you need will depend heavily on the types of machines and their operating environment.

Long-life lubricants in the right application make good sense. They extend drain intervals and lower the cost and risk of premature lubricant failure. Of course, when the lubricant fails, the machine is next. In many cases, selecting a long-life lubricant can reduce oil consumption by more than 50 percent.

Extend the Lubricant's Life

In normal service, lubricants age over time in a linear fashion. Eventually, they die due to additive depletion or other causes. However, life expectancy is not only related to the quality of the lubricant but also to the type and extent of stressful exposures.

The most destructive exposures come from contaminants such as heat, air and moisture. Most users greatly underestimate this opportunity.

Reconstruct Aged Lubricants

In many cases, additives in an aged lubricant should be reconstructed. Rather than disposing of all the oil and then replacing it, a far more economical approach would be to only replace the offending degraded additive. Although this practice may bring criticism from lubricant marketers, there are reputable service providers who can help make good decisions.

Optimizing the Relube Interval

Don't change a lubricant too soon or too late. Many lubricants are changed using regimented practices or simple guesswork. Where possible, use oil analysis as your metric to optimize the interval and avoid premature disposal of an expensive commodity. For instance, if the oil is analyzed at the end of a typical service interval and the remaining useful life (RUL) is found to be 75 percent, extend the interval for the next drain and

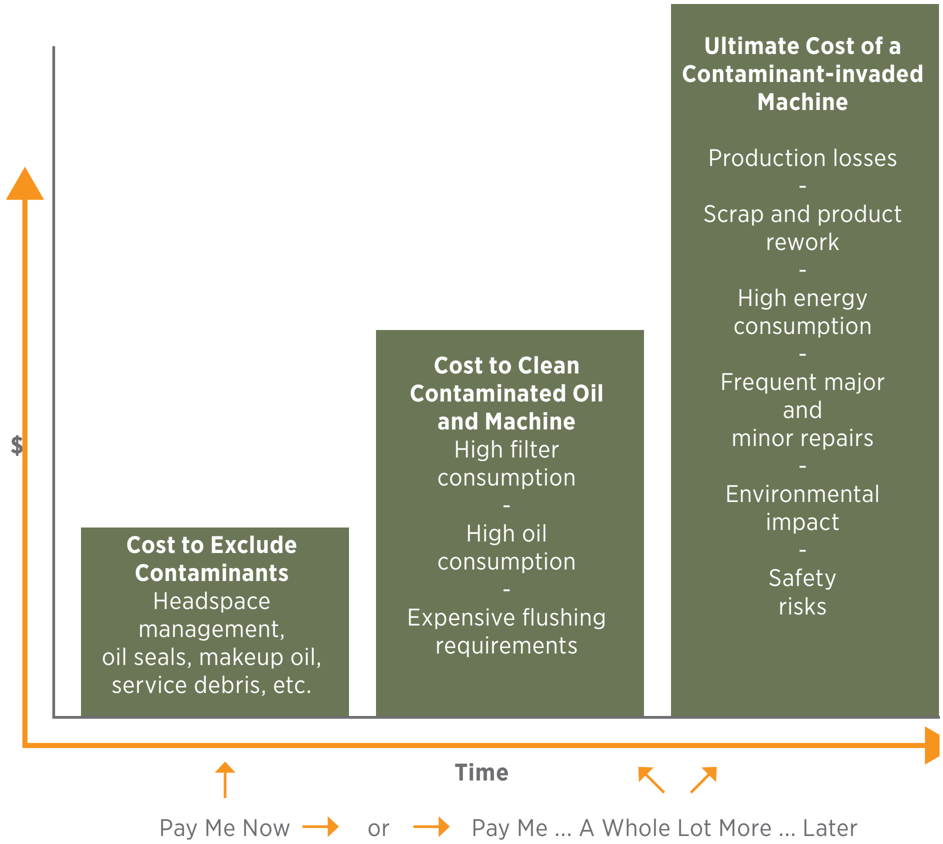

Figure 4. The cost of contaminant invasion

charge. Keep fine-tuning the interval until an optimum interval is found.

Many machines should not be subjected to interval-based oil changes at all. Instead, their lubes should be changed "on condition" and only when there is a true need. Let the oil tell you when it needs to be changed, not the calendar.

In certain applications, grease lubrication can also be optimized from the standpoint of the relube frequency and amount. This can be achieved through grease analysis (with proper sampling) and by inspecting used grease in bearing and motor rebuilds.

Reduce Package Waste

Many lubricants sold in drums and packages fail to get fully consumed. Frequently, unused lubricant is left behind in the package. Various strategies can help to minimize waste oil, including using smaller packages or bulk oil. These tactics should be optimized for the machine or group of machines in which the lubricant is used.

Another culprit of waste is the top-up container. These small containers that are carried to the point of lubricant application are often partially full when they are set aside. The oil left in the container is later questioned regarding its type and condition.

Reduce Leakage

Leakage control makes good sense for a number of reasons. Not only are there lubricant consumption savings but also reliability and safety benefits. Don't turn a blind eye to leakage; address it early. Avoid Band-Aid fixes, and instead seek permanent and complete solutions. Two things greatly influence this: the quality and cleanliness of the lubricant and inspection.

Figure 3 offers a hypothetical example

OPERATING & MAINTENANCE SAVINGS	INITIAL INVESTMENT (NON-RECURRING)	ANNUAL SAVINGS	1ST YEAR RETURN ON INVESTMENT	2ND YEAR & BEYOND
Reducing Your Fuel and Energy Bill	$30	$30	0	$30
Reducing Your Lubricant Spend	$20	$10	$10	$10
Reducing Spend on Contamination Control	$20	$10	$10	$10
Precision PMs, Fewer Work Orders	$10	$30	($20)	$30
Unifying Condition Monitoring with Inspection	$20	$20	0	$20
Total	$100	$100	0	$100
Annual Savings from Downtime Reduction		$50	$50	$400+
Total Return		$150	$50	$450+

Figure 5. Self-funding lubrication excellence through the current operating and maintenance budget

of the potential for reducing lubricant consumption and overall annual lubricant spending. The opportunities vary considerably depending on the current amount of waste and inefficiency in your plant.

3. Reducing Annual Spend on Contamination Control

There is a price tag for removing dirt from oil. For large plants and fleets operating in dusty environments, the cost can be substantial. Where rigorous contamination control is needed (most cases), you still have a few options to get the most cleanliness for the fewest dollars.

Stop the Ingress

It goes without saying that filters last longer when they don't get plugged with particles. Therefore, the best strategy comes from working backward by tracing the contaminant ingression pathway. Then, start the process of exclusion by systematically blocking these free-pass entry points. It often is said that the cost of excluding a gram of dirt is only about 10 percent of what it will cost you once the dirt is allowed to get into the oil (Figure 4).

Select Economy Filtration

This can be broken down into two categories: economic filters and economic filtration. Economic filters relate to such considerations as filter size, media type, dirt-holding capacity, etc. Economic filtration involves the system and operating conditions, such as flow density, pressure and filter location, as well as the use of multiple filters, filter carts, centrifuges, etc. It also is associated with the optimum filter change interval.

Controlling contaminant ingression and optimizing the selection and use of filtration can produce considerable economic rewards. The impact on your energy bill and annual lubricant spend has already been discussed, but there are many other directly related economic factors, including replacement parts, labor, productivity, etc. Getting wise and balanced advice on this can be an economic windfall.

4. Precision PMs, Fewer Work Orders

Preventive maintenance (PM) tasks are resource-intensive and expensive. Optimize your program by recalibrating PMs. Optimization means doing some pruning of wasteful tasks and adding others to fill holes in your PM scheme. Most importantly, bulletproof your strategy to ensure there are no high-risk failure modes that don't have a PM countermeasure (such as inspection).

Assess What Is Being Done

Many PMs are unnecessary or redundant, while others like key inspections are casually ignored. In some cases, condition-based maintenance was added with the intention of replacing scheduled component changeouts. However, these changeouts often continue despite the added condition monitoring. Basic-care PMs are essential to the health of machines and include lubrication, proper fastener management, balance, alignment and other proactive measures to extend the life of the equipment.

Examine How PMs Are Performed

Some PMs do more harm than good. Others perpetuate antiquated methods that should have been replaced with modern tools and methods. Re-examine essential lubrication care related to the well-known "rights of lubrication."

De-risk failure-inducing tasks by upskilling technicians, adding better tools, and re-examining procedures and workplans. Simple tasks like greasing a motor bearing can cause sudden-death failures when performed improperly. Remove task ambiguity such as "check pressure," "check temperature," "inspect electrical system," etc. What do these tasks really mean? Without a clear definition of what OK looks like, inspections can be empty and valueless.

Revisit Task Frequency

Poorly timed PMs waste valuable resources or neglect opportunities. Optimize frequency based on criticality, failure modes and need. The importance of condition-based oil and filter changes (as opposed to schedule-based) has already been discussed.

Grease lubrication is another PM task that is frequently performed at the wrong interval. Sadly, when a machine fails for causes unknown, we often react in a knee-jerk fashion. For instance, we may attempt to remedy things by increasing the regreasing frequency and volume. While the intention is good, this just makes matters worse. Then, the new PM interval becomes the de facto standard, and nobody recalls the reason why.

Design Smart PM Route Sequences

PM routes should be sequenced according to the frequency, required tools, lube type, location (proximity) and urgency. Optimize the routes to reduce wasted time and resources.

Manage Compliance and Backlog

Keep route compliance on a very short leash. Watch work-order backlog and overall maintenance debt very carefully. The worse things get, the faster they get worse. Unfortunately, many organizations get behind on proactive maintenance PMs because they are too busy working on the backlog of urgent repairs. Breakdown maintenance doesn't "prevent" anything. Stop the insanity!

5. Unifying Condition Monitoring with Inspection

For most plants, condition monitoring consists of multiple technologies that are cobbled together in an attempt to enhance machine reliability. Clearly, these efforts are founded on good intentions, and many such programs enjoy considerable success. Still others languish due to a lack of symmetry and central focus. Money is spent and effort expended, but the results are often disappointing.

Condition monitoring requires a strategic and efficient foundation for alignment. This begins with understanding machine criticality and failure modes. Alignment greatly helps to optimize deployment of activities and spending to minimize waste and redundancy. Alignment also keeps maintenance and reliability professionals on the same page by providing a clear understanding of what's being done and why.

Unification refers to bringing all condition monitoring efforts into a purposeful, cohesive focus. This includes vibration, ultrasound, oil analysis, thermography, etc., but it must also incorporate the human data collector who has sensors far exceeding anything technology can offer to look, listen, feel and smell. These super-sensors are wired to a super-computer in the inspector's brain. Ever wonder why airport screening of carry-on bags still depends on humans to analyze and inspect 2D images?

Optimize oil analysis and in certain cases substitute onsite oil analysis. Many non-critical machines can get by with simple onsite oil analysis inspections instead of expensive, full-on lab work (at least for screening purposes). Basic onsite examinations that are extremely effective include patch testing, viscosity comparator, crackle test, clear and bright, and manual ferrous density. Frequently performed inspections at the machine are often far more effective than less frequent lab analysis of oil in sample bottles.

Unification and alignment are an engineering process that has the potential to yield huge benefits in reducing current condition monitoring costs as well as optimizing the state of machine reliability.

What Does It All Mean?

It's very simple: why wait? Warren Buffett once said, "I'd rather be approximately right than precisely wrong." Don't overplan, overprepare or wait for the perfect time. Instead, spring into action now.

Figure 5 is a simplistic tally of how investing in lubrication excellence now can be self-funded painlessly through the current operating and maintenance budget. Yes, some faith or trust is involved, but remember that many others have been down this road. Their amazing results are known and documented for public view. Refer to the countless case studies found at MachineryLubrication.com and make your plant the next documented success story. *ML*

About the Author

Jim Fitch has a wealth of "in the trenches" experience in lubrication, oil analysis, tribology and machinery failure investigations. Over the past two decades, he has presented hundreds of courses on these subjects. Jim has also published more than 200 technical articles, papers and 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.

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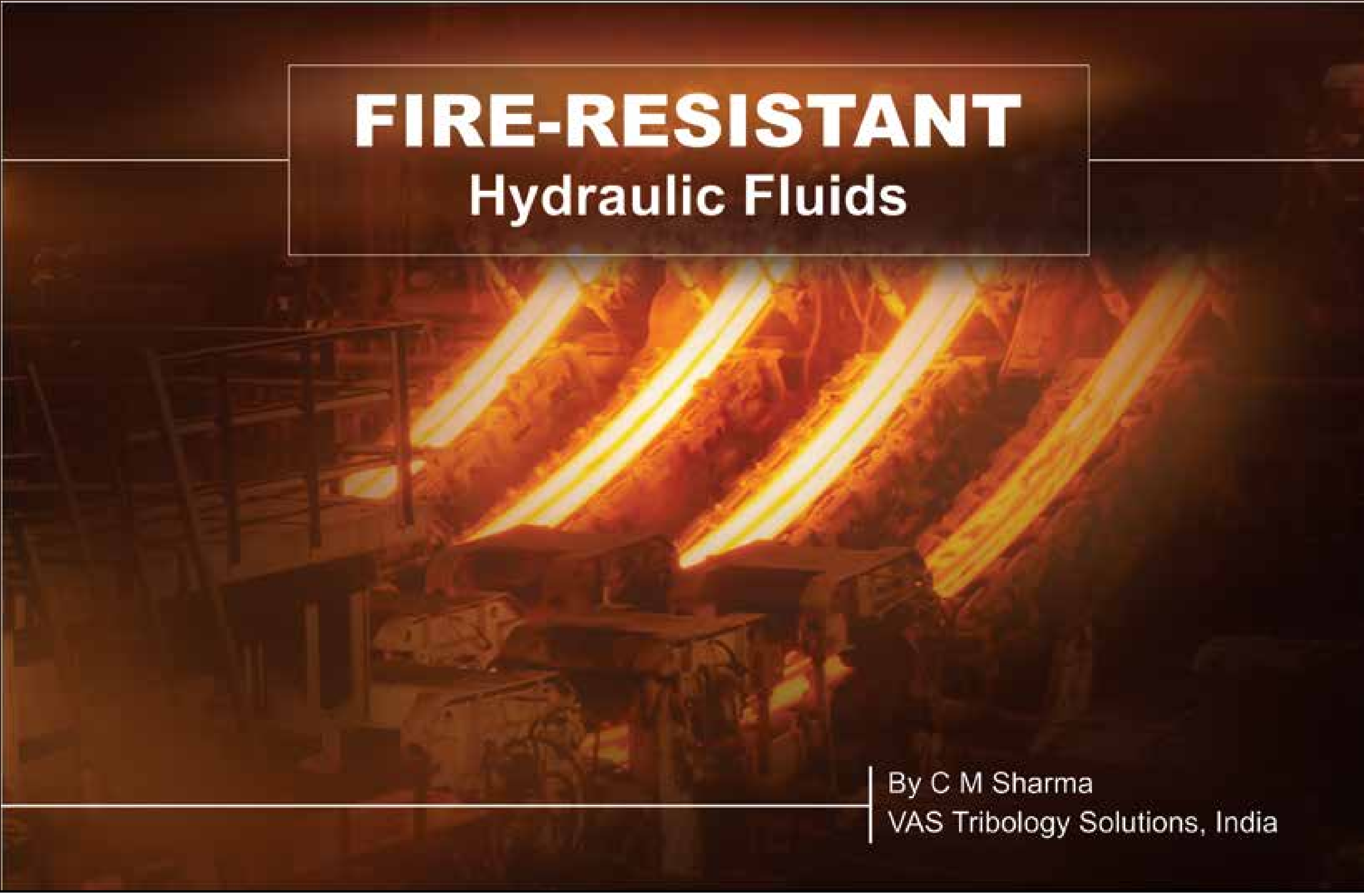


By C M Sharma
VAS Tribology Solutions, India

Steel production in a steel plant where situations occur every day that can be classified as dangerous. With operations involving heavy equipment and liquid or red-hot steel, the danger of fire is ever present. And fire hazards are often exacerbated when mineral oil-based hydraulic fluids are used.

Fire Risks of Hydraulic Fluids

A fire results in the risk of personal injuries, as well as, a likelihood of loss in both capital and production. These losses include not only damage to the building and equipment, but also encompass interruptions in production that can idle production lines for days, or even months.

One cause of fire in a steel production plant is the ignition of mineral oil hydraulic fluids. The highest risk of fire in a steel production plant is the operations, where the processed materials reach temperatures +/-900°C up to > 1500°C. In most of these processes, hydraulic units are used to operate the equipment, and in many cases, a mineral oil-based hydraulic fluid is used to fuel the hydraulic unit. While mineral oil has a definite advantage of a good cost-performance ratio, it is a distillate from crude oil and not always the safest choice due to its tendency to catch fire easily. Fortunately, there are alternatives available to manage this risk and reduce the chance of an ignition without jeopardizing the performance or productivity.

Types of Fire-Resistant Hydraulic Fluids

The standard hydraulic fluids used in steel production are mineral oil based. However, an alternative to mineral oil hydraulic fluids are fire-resistant hydraulic fluids, as described in Table 1 using the ISO 6743/4 classification.

For each fluid type, there are both pros and cons. Table 2 shows a comparison of the properties of several hydraulic fluid types. The properties shown are considered important to maintenance managers.

Properties of Hydraulic Fluid Types

- Mineral oil provides good hydraulic fluid performance attributes at a reasonable price, as shown in Table 2. However, because mineral oil is not biodegradable, it is not environmental friendly. And mineral oil delivers a higher total cost of operation when the risk of fire and worker safety is factored in the cost of use.
- Phosphate ester (HFD-R) fluids, an older fluid technology, are fire-resistant by chemistry. However, they are formulated with materials considered to be CMR (Carcinogenic, Mutagenic, Reprotoxic). The combustion fumes they produce are neurotoxic. While these phosphate ester-based products provide good pump lubrication, they can limit the service life

Table 1 : Fire-resistant hydraulic fluids using ISO 6743/4 classification			
WATER-BASED FLUIDS		WATER-FREE FLUIDS	
HFA-E	Oil in water emulsions · water content >80% · common use 1 to 5%	HFD-R Phosphate	Phosphate ester based. These products are less used because of CMR reputation
HFA-S	Synthetic aqueous solutions · water content >90% · common use 1 to 5%	HFD-U Polyol ester-based fluids	Based on other compounds, but mainly synthetic polyol ester and natural esters (renewable resources)
HFA-S	Water glycol solutions · water content >35%		

of servo valves. HFD-R fluids can be 10-15 times more expensive than mineral oil and need to be carefully maintained, as these products form aggressive acids as they age. Today, they are used mainly in power generation, although they are at times found in steel plants, as well.

- Water glycols (HFC) are widely used in steel plants, as well as other industries, representing approximately 50% of the total fire-resistant hydraulic fluids market. Because of their high water content, HFC fluids provide very good fire resistance. In price, it is comparable to mineral oil and less expensive than water-free hydraulic fluids. However, HFCs don't measure up in performance attributes. Component service life generally is shorter, more fluid management is needed, and energy consumption is 10 to 20% higher compared to mineral oil or Polyol ester-based fire-resistant hydraulic fluids. All issues drive up the total cost of operation (TCO).
- Polyol ester-based fluids (HFD-U) are the best alternative to mineral oil. While they are more expensive than mineral oil (approximately 2 to 3 times more), they deliver a lower total cost when you consider the reduction in fire risk and improvement in worker safety. Also, with Polyol ester-based fluids, manufacturers don't sacrifice the fluid's performance, and they are environmental friendly.

Understanding the Term "Fire Resistant"

"Fire-resistant" is often misunderstood to be the same as "fire-retardant"—or the ability to suppress a flame. The only hydraulic fluids that can truly be considered fire-retardant are the high water content (HFA) fluids. Almost all fire-resistant hydraulic fluids will burn under certain conditions. HFC fluids will ignite if a certain amount of water evaporates. And while most HFD-U fluids will burn, they will not cause the ignition-like explosion that the mineral oil will, which leads to an uncontrollable situation.

Fluids can be tested to determine their fire resistance. The most common and generally accepted tests are those used by Factory Mutual (FM Global), the testing and approval arm of a major industrial insurance underwriter (www.fmglobal.com). By using an FM Global-approved hydraulic fluid, manufacturers can often reduce their insurance premium. Many other organizations and companies have also developed fire-resistance tests, usually to simulate a certain type of real-world accident.

Table 2 : Hydraulic fluid comparison when used in fire hazardous situation

PROPERTY	MINERAL OIL	PHOSPHATE ESTER (HFDR)	WATER GLYCOL (HFC)	SYNTHETIC POLYOL ESTER (HFDU)
Fire Resistance	- -	+ +	+ + +	+
Environmental Performance	-	+ and -	+ and -	+ +
Thermal Stability	+ +	+ +	-	+
Fluid Maintenance	+	- -	- -	+
Component Life/ System Reliability	+	+ and -	- -	+
Price	+ +	- -	+ +	+ -
Total Cost of Operation	-	-	- -	+

Typical Application in Steel Plant	
Blast Furnace	Mud Gun Hydraulics Tap Hole Drilling Hydraulic System
Coke Plant	Stamp Charging Hydraulic System
Steel Melting Shop	Skirt Hydraulic System
	Slag Raking Machine Hydraulic System
	Slide Gate Hydraulic System in Billet and Slab Caster
Hot Rolling Mill	Roughing, Finishing Stand and Down Coiler Hydraulic System
Power Plant	Turbine Governor Hydraulic System

Advantages of HFDU Fluid

- With its considerable fire resistance properties, is associated exceptional lubricating properties which guarantee a substantial reduction in wear, and therefore a longer service life of the hydraulic components.
- High flash point and high spontaneous ignition temperature.
- Low pour-point providing good performances at low temperature.
- Very high natural viscosity index, guaranteeing a viscosity constantly adapted to the temperature range in which the fluid must be used.
- Very good anticorrosion properties in relation to ferrous and non-ferrous metals making up a hydraulic circuit.
- Very good oxidation stability: enhanced service life.
- The product is not expected to produce adverse effects on health.
- Maximum operating temperature is 120°C.
- Readily biodegradable.
- Non-toxic to aquatic life.
- Compatible and miscible with mineral oil.
- Insoluble in water; lighter than water.
- Useful life comparable to mineral oils.
- Shelf life - 12 months.

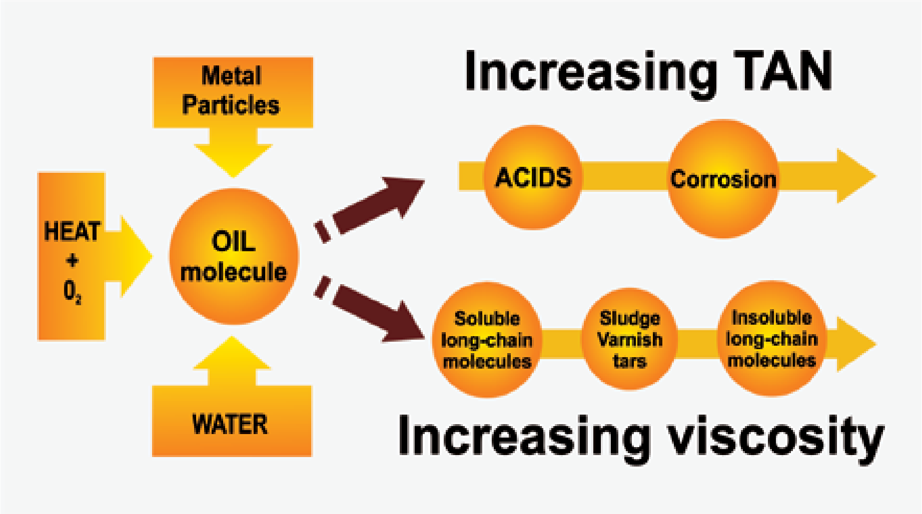
The Vendor test certificate of supplied fluid must have the following information-

- International specifications ISO 6743/4 HFDU & ISO 12922
- DGMS approved FRHF-HFDU-68
- FACTORY MUTUAL in accordance with FM Approval Standard 6930 "Flammability classification of Industrial Fluids."
- Appearance of new fluid- To Report
- Flash point, as per IS:1448 (P, 09)-330 degree C
- Pour point as per IS: 1448 (P, 10)- (-42) degree C
- Kinematic Viscosity at 40 ° C (CST) as per IS:1448 (P-25)- 70.38
- Kinematic Viscosity at 100 ° C (CST) as per IS:1448 (P-25)- 12.82
- Foaming characteristic as per IS: 1448 (P-67)- passes
- Rust prevention capacity as per IS:1448 (P-96)- passes
- Total Acid No. (Mgm KOH/gm.)- 1.1
- Fluid density as per IS: 1448 (P-16)- 0.933
- Water Content as per IS: 2362 (in %) – 0.039
- Fire resistance characteristics as per IS: 7895-passes.

Degradation of Hydraulic Fluid

Sludge - Varnish - Oxidation products

There are numerous types of insoluble contaminants found in hydraulic and lubricating systems. Insoluble contaminants are those materials that will not dissolve in the oil.



The two most general classifications of insoluble contaminants are hard contaminants, such as dirt, debris and wear particles, and soft contaminants, composed of the various oil degradation by-products. Varnish and sludge originate from the soft contaminants. It is a thin, insoluble film that over time deposits throughout the internal surfaces of a lubrication system. The degradation process accelerates as the lubricant undergoes continued exposure to air, water, catalyst (metal particles) and high temperatures.

Sludge contamination is, without doubt, the least recognized as far as hydraulic equipment contamination is concerned. Fact is that sludge is present in virtually every type of hydraulic and lubricating system. Given the fact that sludge is a "soft pollutant", it is not measured during possible oil analyses. Most operators are not aware of its presence in the oil.

Sludge presence can have far-reaching consequences :

1. Increased wear rates- Varnish captures hard contaminants, creating an abrasive surface that accelerates wear.

2. Heat exchangers become less efficient- Sludge deposit adheres to the inside of pipework, thus forming an insulating layer decreasing the cooling effect of heat exchangers. This reduces the efficiency of the heat exchange and results in higher operating temperatures. Again this leads to increased power consumption and to faster oxidation of the oil.

3. The main line filters get blocked- Sludge is sticky, resinous substance, and it therefore stays behind in the pores of filters, quickly blocking them. This may lead to decrease in the flow rate and/or a higher P, and as a result the drive will operate more slowly. It becomes increasingly difficult for the pump to circulate the oil, leading to cavitation, higher power consumption and increased wear and tear. The main line filters need to be replaced more frequently.

4. Valves clog or operate badly- The presence of resins increases friction to 5-6 times higher than nominal value. This will result in higher energy requirements and can cause stuck or seized valves.

5. Reduced clearance zones affecting lubrication- Often, this means a transition from full film to boundary lubrication, resulting in increased wear in pumps, bearings, gears and valves.

6. Increased wear rates- Varnish captures hard contaminants, creating an abrasive surface that accelerates wear.

7. System corrosion and accelerated degradation due to acidic constituents

8. Increased maintenance- Resources and costs required to clean varnished systems.

Choose Change over Experience

Polyol ester technology has been in use for about half a century and in many fire-hazardous applications in steel mills—from blast furnaces to hot strip mills. If a manufacturer makes the decision to change to a Polyol ester fluid in their hydraulic system, the conversion process is not complicated. Typically, no changes need to be made to the hydraulic unit when converting from a mineral oil or water glycol hydraulic fluid to a Polyol ester fluid. Having said that, the conversion must be done with care because there are several grades and qualities of Polyol ester (HFD-U) fluids available on the market.

The important checks that must be performed are not only compatibility evaluations with the existing mineral oil, but also the paint inside the tank, seals, hoses, valves, and pump. In the end, tests will show that the type of paint is critical (single-component paints can be incompatible), as well as pump approvals. It is also important to remember that several different suppliers exist for Polyol ester fluids, but most pump builders only approve some suppliers without any restriction on rpm and maximum pressure. Experience teaches that when paint compatibility is good, no changes or restrictions are needed for the hydraulic system. To guarantee the fire resistance of the new fluid, less than 5% residual mineral oil should remain.

COMPATIBILITY CHART WITH ELASTOMER

The following chart contains our recommendations regarding the use of HFDU OIL with commonly used elastomers. The elastomer applications listed are "Static", which refers to trapped non-moving seals such as O-rings in valve sub-plates and rigid, low pressure hose connections; "Mild Dynamic", whose applications include accumulator bladders and hose linings where the hoses are exposed to high pressure and light flexing; and "Dynamic", which refers to cylinder rod seals, pump shaft seals and constantly flexing hydraulic hose.

Fluids Compatibility

It is compatible and miscible with nearly all mineral oil, phosphate esters and polyolester-type hydraulic fluids. It is not miscible or compatible with water-containing fluids.

Compatibility with paints and coatings

It is compatible with multicomponent epoxy coatings. It shows limited compatibility with one component (zinc-dust containing) coatings.

ISO 1629			
*NBR Medium to high nitrile rubber (Buna N, >25% acrylonitrile)	C	C	C
FPM Fluor Elastomer (Viton®)	C	C	S
CR Neoprene	S	S	S
IIR Butyl Rubber	S	N	N
EPDM Ethylene Propylene Rubber	N	N	N
PU Polyurethane	C	C	C
PTFE Teflon	C	C	C

C = Compatible

S = Satisfactory for short term use, but replacement with a completely compatible elastomer is recommended at the earliest convenience.

N = Not Compatible

Case studies of steel customers who switched to a fire-resistant hydraulic fluid after having experienced the hazards of mineral oil-based hydraulic fluids-

1. Steel Melting shop was operating a billet caster with a standard mineral oil-based hydraulic fluid. In this specific application, there were frequent hose ruptures that caused the oil to be splashed on the recently still-hot casted billets. Each time a rupture occurred, the fluid ignited into a massive fire with vapor clouds forming into fire balls. The fires were difficult to get under control, and each one caused hours of production lost due to downtime. After the customer switched to HFDU fire-resistant hydraulic fluid, while Hose rupture was also controlled by upgrading hose standard and providing Heat protection sleeve ,Hose failure were reduced drastically resulting in no more explosions due to vapurs .Reliability and fire safety of Billet caster was improved. Fire hazard situation due to small fires was quickly brought under control.

2. In a steel mill, leaks were causing the mineral oil-based hydraulic fluid to form a pool on the plant floor. While the operation was going on, liquid metal sparks would land in the oil pool and catch fire. The fire would spread quite rapidly, and although it caused no serious collateral damage, the potential threat was clearly demonstrated. Concerned with what could have potentially happened, the customer performed a test to compare hydraulic fluids for fire resistance. To do this, they placed a red-hot piece of steel into a bucket filled with mineral oil-based hydraulic fluid and another into a bucket filled with HFDU, fire-resistant hydraulic fluid. The bucket containing mineral oil burnt until it was empty (more than one hour). The bucket containing water-free, fire-resistant hydraulic fluid extinguished in less than 60 seconds. Seeing the results, the customer converted to fire-resistant hydraulic fluid.

3. Although seen as a relatively cold area, many fires take place at the pickling line, specifically the hydraulic welder. Several accidents have been reported where hydraulic hoses ruptured and mineral oil-based hydraulic fluid came as a jet stream, landing on the just-generated weld or welding sparks, and set the whole area on fire. This not only caused severe damage in the surrounding area, but also idled the production line for several months. By switching to HFDU fire-resistant hydraulic fluid, the risk of fire spreading to other areas of the plant was strongly reduced, as was long, costly downtime.

4. A steel plant was using mobile equipment to transport hot slag from its steel-making facility when an accident took place. The equipment's mineral oil-based hydraulic fluid caught fire, and the mobile equipment was burned beyond repair. All the mobile units were immediately switched to a water-free, fire-resistant hydraulic fluid.

Condition Monitoring of for fire-resistant hydraulic fluids during Service

Oil analyses have been firmly established in the field of hydraulics for monitoring oil condition and for pro-active maintenance.

Hot Forging Plant

The aim is to increase operational reliability and availability and reduce costs at the same time by:

- Safely adjusting the oil changing intervals to suit the prevailing conditions by monitoring the condition of the oil
- Monitoring the oil purity as the most frequent cause of failure
- Ensuring that operators effectively optimize oil maintenance measures
- Recognizing irregularities in good time to avoid unplanned failures

Due to their special composition and the underlying conditions resulting from their use, fire-resistant fluids require the use of additional special investigation methods.

For the routine testing of HFDU fluids in medium-sized installations, the following parameters are monitored:

- Elemental analysis (Metallic particles, dust, corrosion, additives, tramp oils, salts, e.g. from the water)
- PQ-Index (Magnetic metal particles or contaminants)
- Odor
- Color
- Kinematic viscosity at 40°C (Lubricity and fluidity)
- TAN Value (Oil aging)
- Water Contamination in percentage or PPM
- Particle count analysis

About the Author

Chander Mohan Sharma is BE (Electrical) from Institution of Engineers (India). Presently he is working with VAS Tribology Solutions, as a Senior Consultant in Technical Service. He has worked in Tata Steel, Jamshedpur, in various positions for 30 years and retired as Senior Manager. He has wide exposure to lubrication aspects in steel plants and mining equipment lubricants and lubrication systems. He has been involved with installation and commissioning of lubrication systems in new plants inside Tata Steel, Jamshedpur and Odisha.
Contact him at
cmsharma@tribologysolutions.com

Guidelines for Understanding and Maintaining **Hydraulic Accumulators**

"All hydraulic accumulators, regardless of their purpose, store energy and therefore must be treated with some measure of respect."

Hydraulic accumulators are found in almost every industrial plant. Most facilities have several of them, but they often are misunderstood. Accumulators can be the most dangerous hydraulic components in the mill, not because they are inherently dangerous, but because of the lack of understanding. All hydraulic accumulators, regardless of their purpose, store energy and therefore must be treated with some measure of respect.

Accumulator Functions

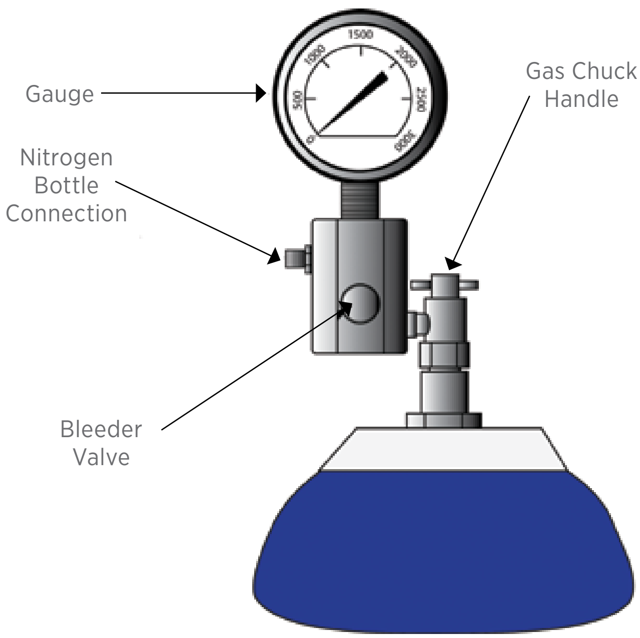
A hydraulic accumulator is used for one of two purposes: either to add volume to the system at a very fast rate or to absorb shock. Which function it will perform depends upon its pre-charge. If the accumulator is to be used to add volume to the system, its pre-charge must be somewhat below the maximum system pressure so oil can enter it. If the accumulator will be used to absorb shock, it must be pre-charged close to the maximum system pressure so there will be little or no oil in it.

Pre-charging an Accumulator

An accumulator typically is pre-charged with dry nitrogen. Nitrogen does not react unfavorably with hydraulic oil under pressure, and since it composes nearly 78 percent of the earth's atmosphere, it is the least expensive gas that can be used safely. The next most plentiful inert gas is argon, which makes up less than 1 percent of the earth's atmosphere.

Under no circumstances should an accumulator be pre-charged with oxygen or air. If compressed oxygen or air encounters even a small amount of any hydrocarbon, it can react violently, resulting in an explosion, fire, injury to personnel and property damage. An accumulator should bear a safety sticker that warns against pre-charging with any gas but nitrogen. New accumulators come with such stickers, but they often are scratched off or painted over.

A charging rig should be used to pre-charge an accumulator.



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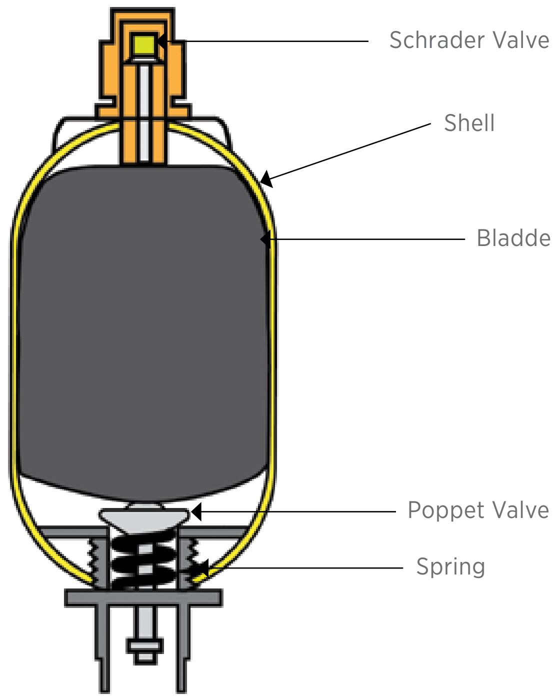


If the pre-charge is too high, the bladder in a bladder accumulator may hit the poppet assembly, resulting in a cut bladder or excessive wear of the poppet spring.

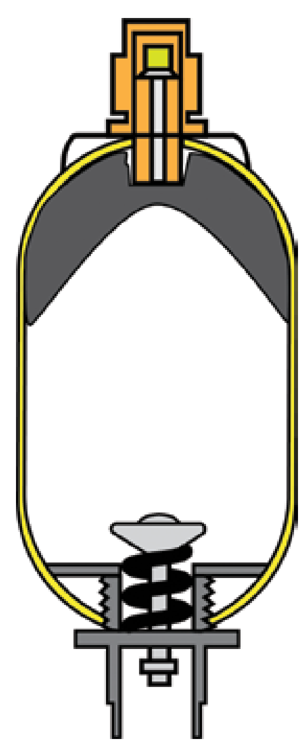
The pre-charge should be performed with no oil in the accumulator. Release any pressure at the accumulator inlet. Most accumulators have a dump valve that can be opened to drain oil to the tank. Screw the charging rig onto the accumulator's Schrader valve and turn the gas chuck handle clockwise to depress the pin. The current pre-charge can then be read on the charging rig.

If the pre-charge is too high, a bleeder valve on the charging rig can be opened to release nitrogen to the atmosphere until the pre-charge drops to its recommended level. If the pre-charge is too low, the charging rig comes with a hose to connect it to a nitrogen bottle. With the nitrogen bottle connected, crack the valve on the bottle and slowly add nitrogen until the pre-charge reaches the desired level.

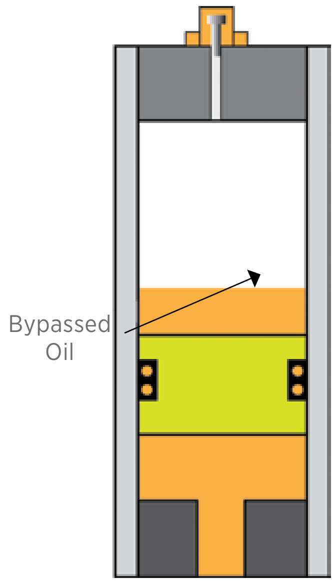
The correct pre-charge varies by the application and type of accumulator. Most accumulators are the bladder, piston or diaphragm type. Follow any recommendations from the original equipment manufacturer (OEM), if they are available. If not, the correct pre-charge can be estimated.

When an accumulator is used for volume purposes, such as to apply a brake in the event of a power failure, to supplement the output of a pump, or to maintain a constant system pressure, most manufacturers recommend a bladder accumulator be pre-charged to 80 percent of the minimum acceptable pressure and a piston accumulator to 7.03 kilograms per square centimeter below minimum pressure. Unfortunately, in many instances, the OEM pre-charge pressure is not available, and the minimum acceptable pressure is unknown. When this is the case, pre-charging to 50 percent of the maximum system pressure usually yields an acceptable result.

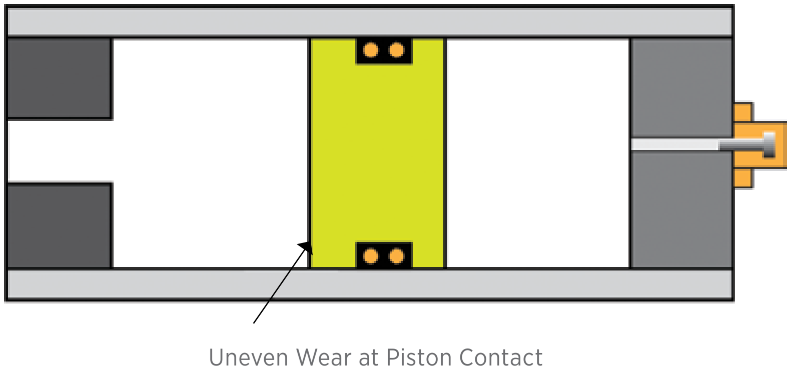
The most common cause of an



If a bladder accumulator loses its charge, the bladder may be pushed to the top of the shell and become ruptured by the Schrader valve assembly.



Over time, oil bypasses the piston seals in a piston accumulator, displacing nitrogen.



Mounting a piston accumulator horizontally can cause the piston seals to wear more rapidly.

accumulator failure is too high of a pre-charge. If the pre-charge is higher than it should be, the bladder in a bladder accumulator will hit the poppet assembly during each cycle, causing either a cut bladder or excessive stress wear of the spring in the poppet. In piston accumulators, too high of a pre-charge can damage the piston and prevent it from hitting bottom at each cycle. Too low of a pre-charge (or an increase in system pressure without a compensating increase in the pre-charge) can also lead to operating problems, such as reduced speed and stalls. It may even result in accumulator damage.

In general, it is better to undercharge than overcharge. However, a bladder accumulator that has lost all or most of its charge may have its bladder crushed at the top of the shell and become ruptured by the Schrader valve assembly.

Adding Volume

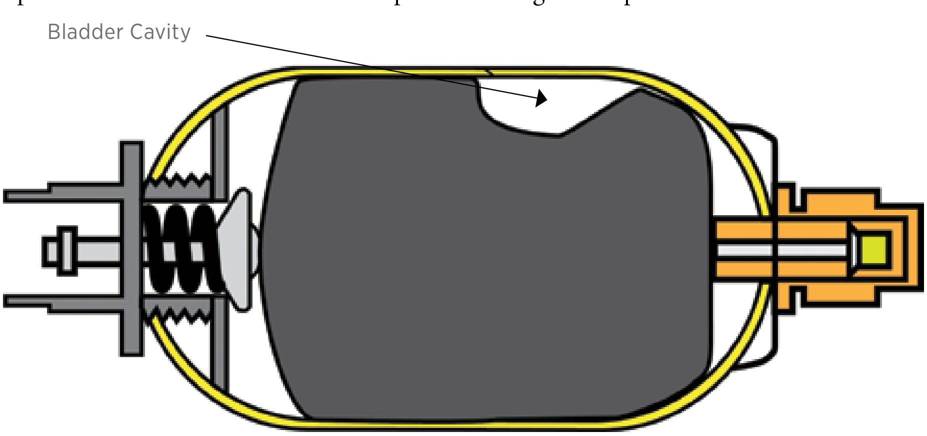
Volume accumulators have a dump line to release pressure whenever the system is shut down. The pre-charge can be checked without the charging rig by watching the gauge fall when the system is shut down and the dump line is opened. The gauge will drop slowly because the dump line normally is downsized to avoid turbulence in the reservoir. When the gauge reaches the current pre-charge of the accumulator, it will then drop immediately to 0 per square centimeter. This also is a good way to tell if an automatic dump valve has opened as it should. When the system is shut down, if the gauge drops immediately to 0 per square centimeter without gradually dropping first, it is likely that the gauge is isolated from the accumulator, and whether the accumulator has dumped will be unknown.

Shock Absorption

When an accumulator is used for shock absorption, it is not desirable that there be much, if any, oil in the accumulator during operation. The accumulator will respond more rapidly to pressure spikes if the compression process has already begun. For this reason, it usually is recommended that shock accumulators be pre-charged to nearly 645.16 square centimeter below the maximum load pressure of the actuator it protects.

It is not advisable to use a piston accumulator to absorb shock. Bladder and diaphragm accumulators are more responsive because they don't have to overcome the static friction of the piston seal, and the mass of the piston need not be accelerated or decelerated.

The piston accumulator is like a hydraulic cylinder with no rod. It is pre-charged with nitrogen and no oil in the bottom. When the system is pressurized, the nitrogen compresses as the bottom of the



If a bladder accumulator is mounted horizontally, a cavity may form between the bladder and the shell, causing fluid to become trapped.

accumulator fills with oil. The nitrogen pressure matches the system pressure, so any reduction in system pressure will cause the accumulator to discharge oil to the system. The accumulator thus will supplement the pump during portions of the cycle when the system demands more flow than the pump can provide.

Over time, oil will bypass across the piston seals, displacing nitrogen at the top. The first indication of this is an increase in the pre-charge pressure when no nitrogen has been added. Because of the bypassed oil on top, the stroke of the piston is reduced. System pressure drops, stalls may be noted, and the piston can become damaged by repeatedly hitting the bottom of the accumulator.

Oil can be removed from the top of the accumulator by attaching the charging rig and opening the bleeder valve with the system pressurized, removing all nitrogen and oil. When oil stops coming out, the piston is at the top. The system can then be shut down, the dump valve opened to drain oil from the bottom, and the pre-charge restored, recovering the accumulator's diminished capacity. If oil never stops coming out of the bleeder valve, the piston is badly worn and must be replaced.

Mounting an Accumulator

It generally is best to mount accumulators in a vertical position with a mounting bracket about two-thirds of the way up the shell. Mounting a piston accumulator horizontally will cause more rapid wear of the piston seals. Bladder accumulators can also be damaged if they are mounted horizontally. In addition to uneven bladder wear, fluid can become trapped away from the outlet if a cavity forms between the bladder and the shell. Diaphragm accumulators usually can be mounted in any position.

Inspecting Accumulators

Hydraulic accumulators should be carefully inspected visually at least once per year, more often in environments unfriendly to steel. Ensure there are no rust spots or cracks in the paint. Look for loose mounting points, worn rubber and any indication of movement during operation. Check all fittings for leaks. At least every five years, the accumulator should be removed from service and hydrotested. Finally, never attempt to repair an accumulator shell. If there are any breaches, the shell should be discarded and replaced. ***ML***

About the Author

Jack Weeks is a hydraulic instructor and consultant for GPM Hydraulic Consulting. Since 1997 he has trained thousands of electricians and mechanics in hydraulic troubleshooting methods. Jack has also taught radio-wave propagation for the U.S. Air Force and telecommunications equipment operation and repair for the Central Intelligence Agency at American embassies overseas.

Srikanth Anchula | VAS Tribology Solutions

Setting up Your Onsite Oil Analysis **Test Facility – Pros & Cons**

"On-site oil analysis is best used as a screening tool for equipment. For facilities that handle large sample volume, on-site analysis can help optimize the efficient use of a commercial lab"

When you require lubricant testing, you desire a location that offers convenient timings and quick results. Onsite laboratory testing and screening services not only minimize wait times for results, but also decrease the cost related to visiting different locations for lab work.

When a company decides to initiate on-site oil analysis, obvious questions such as: "What tools and equipment are we going to use?" and "What types of tests do we want to perform on-site?" are typically asked. These questions are quickly answered with another question: "What kind of budget do we have for this project?". In particular, having onsite oil analysis facility can significantly reduce the total turnaround time between sampling and condition-based maintenancerecommendations that are required to keep equipment operating safely and efficiently.

Reasons for Onsite Analysis

The primary purpose of onsite oil analysis program is to be able to determine lubricant quality and machine conditions for emergent situations, helping to ensure that all safety-related and supporting equipment is maintained and available for operation.

In addition, offsite oil analysis can be costly and slow. While the costs for expedited oil analysis are insignificant compared to lost production costs, the fastest possible turnaround time may be insufficient to keep equipment operable and the plant online.

The application of onsite laboratory test outcomes in diagnostic decision making is an inherent part of recommendations. There are four primary valid reasons for considering a laboratory test:

1. Diagnosis (to include or exclude a diagnosis)
2. Monitoring (for example the impact of equipment condition)
3. Screening (for example for inline condition monitoring)

4 Research (to learn about the equipment and lubricant failure)

Each of the laboratory test results must be understood within the context of your overall equipment health and should be utilized along with the remaining exams or tests.

Benefits of onsite Laboratory Testing and Monitoring

On-site, comprehensive laboratory testing offer a convenient means for you to obtain your required test results as quickly as possible. Onsite laboratory generate these five major benefits for equipments and practices.

1 Prompt Diagnosis - The ability to perform lab tests onsite and quickly access the results during the laboratory diagnose or supervise an equipment condition immediately.
2 Improved equipment Engagement - Equipments obtain their test results during a laboratory analysis and view the results firsthand are more inclined towards being better engaged with their recommendations.
3 Timely Decisions - Getting lab results onsite at an equipment location supports a start or adjust a timely action taking course for an equipment with a savior condition.
4 Faster Prognosis - With instantly accessible lab results onsite at an equipment location, technicians can immediately direct a deteriorating case towards an emergency.
5 Behavioral Counseling Opportunities - Equipments view their onsite lab results can get behavioral guidance from technicians including modifications to their operating conditions and more for managing their monitoring and maintain good condition.

An on-site oil analysis laboratory is a useful addition to the condition monitoring arsenal. However, users must be aware of the failure potential and the root causes that may be attributed to this, including incorrect instrumentation selection, incorrect test selection, poor personnel and information-flow management, and incorrect or no assimilation with a commercial laboratory. Understanding the pitfalls of embarking on such a project is vital to ensuring its success.

Sometimes budget may be a constraint in setting up an onsite test facility (Lab). In which case it is suggested that this may be set up in stages. Starting with basic test equipment like viscosity, moisture, patch test etc. These tests can provide indicative results on the condition of the lubricants and decision can be taken to filter or change the lubricant if required in time before the equipment damage takes place. These test equipment do not cost much and can be used by plant chemists / technicians easily. Advanced Diagnostic test equipment like particle counter, Ferrography etc. can be added later in stages.

About the Author

Srikanth Anchula is a Mechanical Engineer and certified MLA-II Lubrication Analyst from ICML, USA, has 6 years of experience in lubricant monitoring and lubrication management with hands-on experience of machinery lubrication related issues with various industrial segments like Cement, Steel, Petrochemical, Power generation & Manufacturing, etc. He is currently working as Lubrication Engineer at VAS Tribology Solutions, India.
Contact him at sales@tribologysolutions.

Manoj Srivastava

You Observe Diesel Smell in Open Gear Lubricant

While passing by cement plants, you must have noticed rotary kilns. These can be clearly identified from quite far by their shape – long horizontal cylinder slightly inclined at one end.

And those who have visited cement plants are aware that to enable them to rotate, they are provided with gears mounted on their outer surface, at one end. And since they are not enclosed hence the name – open gear.

These open gears are lubricated by open gear lubricants (OGL). This is a pumpable grease. The application is usually by spray lubrication and a lot of expertise is involved in the manufacture of these OGL and fixing the quantity i.e., quantity sprayed per minute.

The incidence dates back to when I was working with one of the manufacturers of open gear lubricants. We received a complaint from one of the reputed cement manufacturers that their OGL drum was having diesel. The actual complaint was that the grease was not stable to temperature and on application was becoming thin and smelling like diesel.

Since I was directly involved with the manufacturing of the grease, I was confident that diesel could not have entered the OGL drum at manufacturing end except for deliberate sabotage. Also the formulation was time tested for such application. Over the years it was being used in cement industries around the world with no complaints of thinning. So a quick but systematic investigation was carried out at our end.

i) The batch log-sheet was verified to ascertain whether specified procedure was followed and all parameters maintained as specified.
ii) The batch retainer sample was checked and found to be OK.
iii) Drums from same batch at another customer had no complaint.

Since the cement company had been a long-standing customer, we decided to visit their plant to investigate the issue.

As soon as we arrived, we were taken to their maintenance workshop. And there, we were shown one of their drums which was without lid. The customer representative had a meter long steel pipe by which he stirred the contents and showed us. It did not require any testing to see that it was a low viscosity product (but more viscous than diesel) and also smelled like diesel.

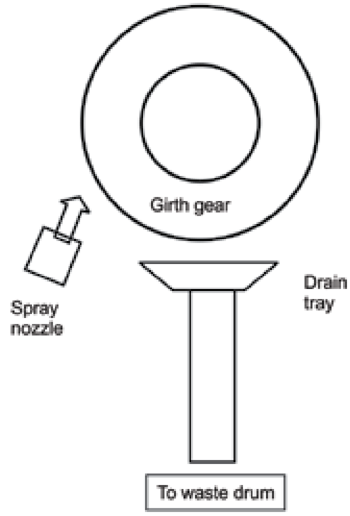
Further he went on to show us their record sheets to convince us that the temperature of kiln had not increased beyond recommended range.

We asked them to show a sealed drum, so we were taken to their warehouse. We got the drum opened in our presence and we evidenced to the customer's representative that the content was perfectly like usual OGL grease and not thin. We offered to take a sample and get it tested in our lab and send them the report. But he was not satisfied saying that the OGL was not of good quality and would get thin on application and hence damage the gear. [Rectification cost of a damaged girth gear runs into lakhs of rupees]. Now this was quite puzzling, there seemed to be no logical explanation for the thinning of grease and the diesel smell.

At our wit's end, we re-sealed the drum and requested him to show us point of application i.e. the spray system on the girth gear. So, we climbed up to the top platform of the rotary kiln; inspected the girth gear and spraying system. Everything seemed to be in order. We climbed down and with sad faces asked for cotton waste to wipe our hands.

The customer's representative directed a helper to give us cotton waste and then take us back to his office. We went into the room which houses the OGL pumping station. We took some cotton waste kept there and were wiping our hands and noticed diesel smell in the room. On enquiring, the helper showed us an open drum with diesel. Out of curiosity, we asked why diesel was kept there. And then the story unfolded.

A couple of days ago, shut down for maintenance was planned for the kiln. The girth gear was completely cleaned using diesel. The arrangement at girth gear is shown in the sketch. It has spray nozzles which sprays OGL on the girth gear. Due to rotary motion, some portion of the OGL gets thrown due to centrifugal force. There was a tray



below the girth gear to collect this and a wide pipe attached to allow it to drop down to a collecting drum, which was kept in the OGL pumping station room.

So, when the girth gear was cleaned, a mixture of OGL and diesel got collected in the drum. It went unnoticed and was not shifted out from there during maintenance. When the kiln was started someone noticed this drum and the thin OGL with diesel smell issue went right up to the senior plant management. And from them the complaint was passed on to us.

We concluded our visit by meeting the senior engineering manager who thanked us for the investigation.

In our report, we recommended that the waste OGL should not be collected in branded drum. This would avoid confusion and also prevent its use by someone attaching it to OGL pumping station. In fact, this is also a requirement as per ISO standards.

About the Author

Manoj Srivastava graduated as Chemical Technologist. He has 32 years rich experience in strategic planning, plant operations with proven abilities in enhancing production process operations, optimizing resources, capacity utilization, escalating productivity & operational efficiency while curtailing costs and expenses in various lubricant companies in India and Africa (Tanzania). He is experienced in carrying out lube surveys/ audits & lubrication training for end customers.
Contact Manoj at manojsri64@gmail.com

Alejandro Meza | Noria Corporation

Lubrication Excellence: **A Short- or Long-Term Initiative?**

"Successful implementation of best practices will consider the technological, organizational and human factors related to the project."

While assisting many different organizations in implementing lubrication and oil analysis best practices, Noria has identified a few common approaches for companies aiming to achieve a world-class lube program. This article will share some of the insights that have been learned through the years to help you select the best strategy for your plant.

Short-Term Initiative

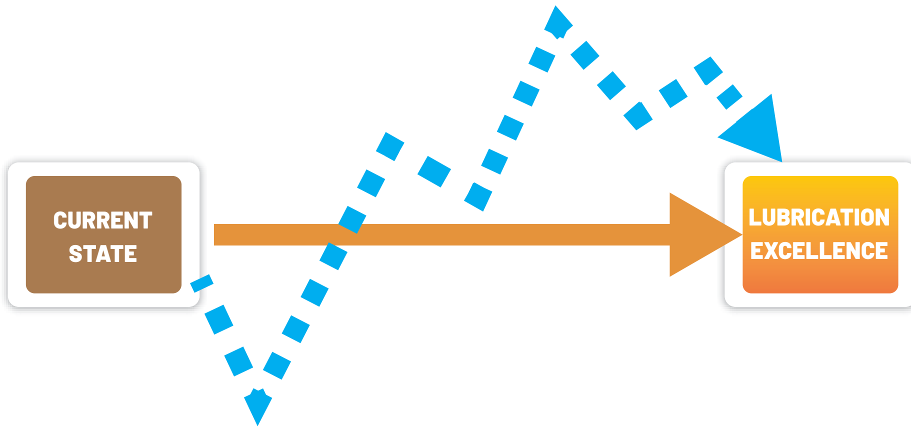
The first approach is when top management has been convinced that there is value in implementing a reliability initiative with lubrication and oil analysis as key elements. Previously, lubrication tasks may have been considered dirty or less important work, but now they have become more valued in both operational and financial terms, and for that reason deserve attention. It also is understood that investments in equipment reliability will pay back the organization in a relatively short period of time, so it will be beneficial to allocate a budget and invest in the initiative.

The program generally begins with an assessment to determine where the company is in terms of its current practices compared to best practices along with the goals. A financial assessment may be included to offer a better idea of the gains the organization is seeking. This type of assessment reports the current situation with a holistic perspective while making it clear that a lubrication program involves multiple organizational levels. Success will depend on the combined work of the team or department involved in the financial decisions and operations, as well as the execution of the maintenance and reliability programs.

The chosen team, which is formed from different levels of the organization, should establish the plan, goals and milestones, and allocate resources. They should know that at times many initiatives will be happening at the same time and that unexpected situations may arise, but they must focus on the goal and understand its relevance.

The second step consists of defining the technical parameters to be followed, such as designing a program for lubricant selection, preventing lubricant contamination, selecting training programs for team members, creating new procedures, identifying key performance indicators (KPIs), and establishing a rewards program.

Key connections may be made across the program. For example, machine modifications can help improve visual inspections and consequently contamination control and lubrication practices. Better oil sampling procedures may enhance the quality of oil analysis and machine condition diagnosis. Machine modifications may be supported by better written procedures and training, which also contribute to improved team performance, increased machine reliability and a reduced failure rate.



This illustration depicts the different paths of a long-term (blue line) and short-term (orange line) approach to achieving lubrication excellence.

The next step is to implement everything that has been carefully planned and designed. This includes installing machine modifications, improving lubricant management across the facility, providing the necessary training, employing and reporting KPIs to observe improvements in machine reliability, etc.

One element that should not be overlooked is defining a specific mechanism for managing change in the organization. This will help to ensure everyone involved in the program contributes to sustainable changes.

Periodic reviews can show the progress of the initiative. The results may be expressed in different ways, such as a reduction in operational costs, fewer unexpected shutdowns, lower component/machine replacement rates, decreased labor costs, optimized lubricant purchases and stock control. As long as the project continues, more involvement by the team should be expected along with greater satisfaction from the work.

Successful implementation of best practices will consider the technological, organizational and human factors related to the project. These principles apply not only to lubrication programs but also to other maintenance strategies as well. This type of approach demands top management support, allocation of resources, teamwork, focus and persistence. While it may take several months or longer, eventually the rewards will come.

Long-Term Improvement

Although the short-term approach sounds great, some plants may not have the necessary resources available. In these situations, the reliability/maintenance group might choose a different strategy, one that isn't as demanding on resources but still feasible for implementing best or better practices. This would involve allocating fewer resources in terms of time, labor and money, and would not require much support from upper management. Described as a continuous improvement initiative, it will take a longer time to achieve the desired conditions, but it may be perceived as the best option for attaining lubrication excellence.

In this scenario, top management may not provide formal support of the initiative or even be fully aware of the plan. The authorized budget for the lubrication program might be limited. Due to the restricted resources, a full assessment of the program may not be conducted. Consequently, there likely is not a holistic vision of the improvement opportunities and their potential impact. Instead, the focus is on more tangible or evident conditions, which can result in important program elements being missed.

Solutions often are deployed randomly based on the available resources or ease of implementation, with the steps not necessarily completed in the ideal sequence or timeframe. For example, improvements might include acquiring filter carts, installing high-quality breathers or providing formal training for a few team members. Other changes are made according to the available resources (time, money, machine availability, etc.).

The success of the initiative primarily will depend on the involvement and persistence of one or a few members of the reliability/maintenance team. Since a long-term path has not been defined, only short-term steps are taken. Achievements are celebrated when a step is completed.

With this approach, it will be difficult to estimate the amount of time required to achieve lubrication excellence, as it will be contingent on the available resources. Also causing a blurry vision of the future is that the lubrication program may not be viewed as a system of interconnected factors that produce equipment reliability benefits. This can dilute the impact of the efforts taken. While benefits will be seen, they may take longer to be realized.

Milestones and time-based goals may be incomplete or non-existent, as there likely is no formal metric system. If less favorable conditions are present, the length of time for the implementation could be indefinite. Even after years of work, the results tend to be limited. While this risk exists with any project, the longer it takes for change to be made, the more chances it has to be diluted over time unless there is a culture of formal support.

Although a long-term improvement initiative generally is full of good intentions and hard work, the benefits are more difficult to achieve and typically take longer. Eventually, the team may become frustrated. As with any long-term project, persistence will be key. With all things considered, this may not be the best approach to reach the desired goal.

The illustration on page 25 shows the path of both approaches. The orange line represents a short-term project with focus, vision of future goals, milestones and support from upper management. The blue line characterizes a long-term continuous improvement initiative with an unclear vision of the goals and future status of the program, which typically requires more energy and time to reach the desired destination.

If you find that your program is somewhere in between these two approaches, keep in mind that the more attributes it has of the short-term approach, the more chances it will have to make an impact on your plant's equipment reliability.

Suggestions for a Successful Implementation

Following are suggestions for successfully implementing lubrication excellence, particularly if your current program is more like the long-term approach. Start with quality training for both those responsible to make the improvements and for the team that will support the initiative. This will open eyes and create awareness of the possibilities and benefits. Remember, training is fundamental to ensure appropriate attitudes, behaviors and reliable work.

Next, make a list of improvement actions to be completed and their potential benefits. Involve management as much as possible by sharing case studies, presenting your plans and needed resources, and providing evidence of good work performed.
Develop a plan and communicate the potential value, which is the justification for your actions. Do not allow changes to just be verbally implemented. Make every effort to guarantee that the initiative will prevail by modifying procedures, work orders, etc.

Recognize and reward the contributions of others when a better idea is executed or implemented. Finally, do not stop. Be persistent and communicate the results. *ML*

3 KEY FACTORS FOR LUBRICATION EXCELLENCE

To achieve lubrication excellence, you must take into account three key factors: training, infrastructure/tools and methodology. **Training** creates awareness of the proper work to be completed, while the **infrastructure and tools** involve the physical resources that provide the environment and hardware to perform the job. The **methodology** is the procedural element that must be executed in a consistent, effective and ergonomic manner. If only one or two of these three factors are implemented, some improvements may occur, but the chances of overall program success are low. For instance, new procedures may be written and distributed, but if poor or no training is made available to personnel and no new tools or hardware are provided, the result will be a less than desirable outcome.

About the Author

Alejandro Meza is a senior technical consultant with Noria Corporation. He has more than 20 years of experience in the lubricant industry, technical services, quality assurance, training, consulting and development in the United States, Brazil, Mexico and the Americas region. Contact Alejandro at ameza@noria.com to learn how Noria can help you achieve lubrication excellence in your facility.

Joe Anderson | Reliability X

How to Show the Value of **a Lubrication Program**

"If you follow this advice, you will start to change the perception of the lubrication program within your facility and begin to develop the much-needed credibility to be seen as the subject-matter expert you were hired to be."

To sell an organization on the value a lubrication program can offer, it is important to translate the program into true value. However, you first must define what value is. According to Merriam-Webster's dictionary, value is "the monetary worth of something: market price; a fair return or equivalent in goods, services or money for something exchanged; relative worth, utility or importance."

Value shown by a lubrication program can take on many forms. Most of these can be tied back to monetary value. See Jim Fitch's "5 Ways to Monetize Lubrication Excellence Now" article on page 3. The focus of this article will be on capturing and showing this value in the form of savings and avoidances.

Before you can show the value of your program and share it with others, a few factors within your facility must be understood. The first relates to the costs. Schedule a meeting with your finance department to learn the costs associated with maintenance cost per unit, cost of goods sold (and how it is calculated), total cost to produce, annual electrical costs, cost per kilowatt-hour, and total labor cost per hour by line. This is a good place to start.

Next, try to understand how the finance department calculates these items and ask how savings are quantified. Every department is different when it comes to capturing savings. Some only want to see cost savings, while others accept cost savings and avoidances.

Capturing Savings or Showing Value

Perform an amp draw before and after a lubrication-related issue has been corrected. Start with a pilot project. As you receive the results, expand the solution. Remember to capture data from these machines both before and after proper lubrication practices have been implemented. This can add up to significant savings if tracked correctly. See the example on the right.

Machine		Amps	Volts	kW	Time/Hours	Cost per kWh	Cost
Pump 1	Before	10	480	4.8	720	$0.07	$242
Pump 1	After	5	480	2.4	720	$0.07	$121
						Savings	$121
Machine		Amps	Volts	KW	Time/Hours	Cost per kWh	Cost
Compressor 1	Before	65	480	31.2	720	$0.07	$1,572
Compressor 1	After	59	480	28.32	720	$0.07	$1,427
						Savings	$145
Machine		Amps	Volts	KW	Time/Hours	Cost per kWh	Cost
Evaporator Fan 1	Before	33	480	15.84	720	$0.07	$798
Evaporator Fan 1	After	26	480	12.48	720	$0.07	$629
						Savings	$169
Machine		Amps	Volts	KW	Time/Hours	Cost per kWh	Cost
Extruder 1	Before	32	480	15.36	720	$0.07	$774
Extruder 1	After	28	480	13.44	720	$0.07	$677
						Savings	$97
						Total Savings	$532 per month
						Annual Savings	$6,387

Example of the savings that can be achieved when good lubrication practices are implemented

You can eliminate some labor requirements by utilizing automatic lubrication systems and single-point lubricators. Focus these resources in other areas to allow you to get more work completed within the facility.

Asset life extension has savings associated with it as well. When you extend asset life, you minimize downtime, gain throughput, lower costs, etc. To extend the life of your assets, establish a best-practice oil cleanliness level. Also, use precision lubrication with ultrasound and install breathers on gearboxes, blowers, etc.

Share the Value You Have Captured

There are three types of value on which you should focus: convenience, process improvement and financial value.

Convenience

Convenience is sold through a demonstrated or statistical approach to prove that a plant will be safer and produce higher quality product, which in turn creates less work and rework. Becoming more efficient means less hard work, while lower costs offer a marketing advantage, which translates to job security. Fewer or no environmental incidents will lead to greater job security as well. However, the greatest benefit is empowering workers to do what they know to do by providing the proper tools and removing any obstacles. This improves the quality of life at work and at home. Waking up and wanting to go to work in the morning is a good place to be.

Process Improvement

Process improvement is sold through less downtime, which translates to running to plan. This will make the production manager look like a superhero. Asset utilization improves capacity, which means more volume, more profit and more recognition. Also, less downtime results in less frustration, which raises morale and helps to drive the culture change. This is seen as success in your peers' eyes. It decreases their stress level as well.

Financial Value

Financial value is sold through freeing up cash flow, reduced costs and higher profit gains, all of which translates into higher stock value and more capital for reinvestment into the company. You can begin by announcing to the plant that you are starting your campaign. Then, capture as many cost savings and avoidances as possible. Share your findings with the world. Get creative. You might create a newsletter and share your "value of the week." Send it to everyone in the company. Be sure to verify the costs with your plant's financial expert before publishing it.

If you follow this advice, you will start to change the perception of the lubrication program within your facility and begin to develop the much-needed credibility to be seen as the subject-matter expert you were hired to be. *ML*

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

Preventing Water Contamination

Excessive water can create emulsions in bearing oil, reducing lubrication effectiveness. The formation of deposits onto component surfaces compounds the problem. When water and polar chemicals are combined (even trace amounts), the lubricant's demulsibility (water-shedding ability), corrosion protection and anti-wear capabilities may be compromised. Water contamination can cut bearing life by as much as 80 percent.

Know the Pour Point

The pour point is the lowest temperature at which an oil will flow. This property is crucial for oils that must flow at low temperatures. A commonly used rule of thumb when selecting oils is to ensure that the pour point is at least 10 degrees C (20 degrees F) below the lowest anticipated ambient temperature.

Check Your Records to Control Oil Losses

If you decide to implement a program to control oil losses, one of the first steps you can take is to check historical records of the amount purchased compared with the amount sent for disposal. Try to account for the difference by looking for leaks, products consumed in the process, evaporative losses and products wasted due to contamination or misapplication.

What You Should Know When Using Additives

Regarding the use of aftermarket additives and supplemental oil conditioners, keep in mind that some base oils respond well to additives while others may not. Also, increasing the percentage of a certain additive may improve one property of an oil while at the same time degrade another. When specified concentrations of additives become unbalanced, overall oil quality can be affected. ***ML***

Did You Know?

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

Have Some Tips?

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

TEST YOUR KNOWLEDGE

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

1. Adhesive wear can be described as:

A) The adhesion of wear debris to a layer of varnish
B) The adhesion of a layer of oil to the metal surface
C) The transfer of silicon particles from one metal surface to another
D) The transfer of metal from one surface to another through a localized welding process
E) None of the above

2. Oil samples from an off-line (kidney-loop) filtration circuit should be taken:

A) Downstream of the pump, upstream of the filter
B) Downstream of the reservoir, upstream of the pump (before the pump)
C) Downstream of the filter
D) From the sump
E) From the drain plug

3. Compatibility of different greases:

A) Is only a minor issue and often can be ignored
B) Is a major issue that is dependent on the thickener used
C) Is independent of the thickeners used
D) Can be linked to the age of the grease involved
E) Is dependent only on the base oil used

ANSWERS

1. D

Other names for adhesive wear include galling, scuffing, seizing and severe sliding. Adhesive wear normally occurs during machine starts, loss of film strength and overload/overspeed conditions. Proper lubricant selection is essential to control this wear mode.

2. A

This is to assess the actual condition of the oil before it gets filtered.

3. B

Compatibility of different greases is a serious issue that mainly depends on the thickener type. In general, most grease thickeners are incompatible, so extreme caution is required when switching from one grease type to another.

Daniel Rader | L3Harris Technologies

How to Perform **Lubrication Tasks Safely**

"When it comes to the specific tasks associated with a lubrication program, the general safety training and knowledge in most plants is insufficient."

When most people think about safety, they usually consider their personal responsibility for staying safe. At any plant I visit, safety typically is among the first topics discussed, and it's almost always targeted toward what individual actions must be performed. This includes which personal protective equipment (PPE) to wear, what areas to avoid, which sirens or alarms to be aware of, what the fire or severe weather plan is and other related items. Many sites even have employees and contractors wear a visible sticker or badge that shows a proper safety briefing has been completed.

However, when it comes to the specific tasks associated with a lubrication program, the general safety training and knowledge in most plants is insufficient. Safety should be the top priority on a jobsite, and the lubrication program's design should be part of this safety prioritization.

When establishing a culture of safety around your lube program, there are six main elements to consider: general safety, training, storage, handling, worksite monitoring and disposal.

General Safety

Work within the existing safety programs at your site. Take advantage of the rules and regulations currently being enforced and decide how they apply to lubrication practices. Your company has already committed to employee safety and well-being, and determining how your actions fit into these existing practices will go a long way toward your success.

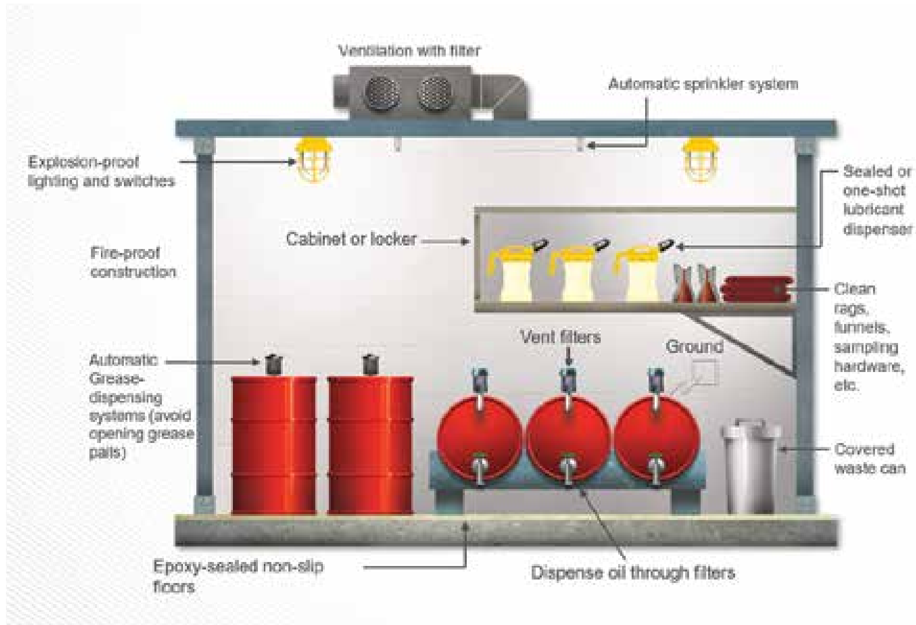
For example, many oil sampling or fill points can be in hard-to-reach locations. Guidelines likely are in place for how to properly gain access to those spots, such as fall protection for working aloft or how to position a ladder to reach over a run of piping. Incorporate the current safety framework

at your jobsite, from PPE to cleanliness and anything else the health, safety and environment (HSE) team has set in place to ensure overall company safety.

You should also work with your HSE team to contribute lubrication knowledge to existing safety standards. Help them identify hazards and assess risks in specific lubrication matters. Lubrication is used to help equipment move, and by definition, moving equipment is dangerous. Perform a comprehensive survey to examine hazards in the workplace, such as the work area layout, as well as activity hazards like the specific machinery being used and environmental hazards like combustible dust. Create written procedures for lubrication activities in the same way you would for other maintenance or HSE-related work.

Training

Train on safety regularly. Along with incorporating current HSE practices into your lubrication program, you also should train all personnel in the particulars of lubrication safety. For many, this will just be general awareness training and can be added to the annual queue of refresher training that the HSE team rotates through, similar to confined space or hearing conservation.



An example of a proper lubricant storage room

For those who are more actively involved in performing lubrication actions, a more robust safety training will be needed. Specific knowledge of the location and identification of lubricants using the safety data sheet (SDS) program will be vital. Consider including hands-on training sessions for sampling and drain/fill evolutions.

Some good rules of thumb for when to provide training would be for first-hire employees (general safety and job specific as needed), when an employee is changing positions or responsibilities to include more lubrication, or when a change or implementation in processes is being made, such as a new lubrication type being added, a new piece of lubrication equipment being used, or some other hazard or condition being introduced. Refresher training should also be offered based on the company or group need or by regulation (at least annually).

Storage

As the old adage states, an ounce of prevention is worth a pound of cure. Properly storing and containing oils and greases will go a long way toward making your lubrication program safe. There is no single right way to store lubricants safely, but there are many wrong practices for managing lubricant storage. Common factors that contribute to stored lubricants being unsafe are as simple as weather exposure or storing lubricants in high-traffic areas. Precipitation and direct sunlight can corrode barrels and other metal connections. Corrosion may result in leaks or escaping fumes from barrels or other storage totes.

Exposure to the environment can also damage the lubricants. Damaged oil being pumped through your systems can lead to earlier machine failure and possibly catastrophic failure, which is far more alarming for most workers than spotting a sheen of oil heading to the environmental drains.

Design your lubricant storage to help prevent spills or leaks by keeping lubricants inside and away from high-traffic areas or pipes that are known to leak or vent, such as steam traps. Store tools and smaller lubricants like greases in specially designed lockers to prevent fire or contamination. Additional ventilation or atmospheric monitoring may be needed to meet air-quality regulations. Follow all guidelines established by the Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA) concerning the storage of lubricants, including oil breaks, approved drains, stacking and positioning of containers, and fire suppression or ventilation systems. Work closely with your HSE team to ensure any changes to your lubrication program take these regulations into account.

In the illustration above, you can see many of these safe practices at work. The lights and electrical are rated as explosion-proof, a ventilation system has been installed in the ceiling, a fire-suppression system is employed, the floor is sealed to prevent seepage from leaks into the ground, and there's a proper waste-disposal receptacle for rags and other rubbish.

Handling

While many lubricants are nontoxic, some may contain a trace mineral or ingredient that can cause a reaction or injury if mishandled. Read the SDS for the lubricant in question and keep copies readily available for workers who use the area.

Some common lubricant classification types are listed above with approximate toxicity concerns. Additionally, the American Petroleum Institute (API) has classified all lubricants into one of five groups with specific warnings. Group I lubricants have been identified as having sufficient evidence of carcinogenicity to humans. The carcinogenetic component is called a polycyclic aromatic hydrocarbon (PAH), also referred to as an aromatic. If your facility handles Group I lubricants, be sure to take extra precautions, such as large placards or other warning signs to keep unknowledgeable team members away.

Similarly, Group II lubricants have been identified as having possible carcinogenicity to animals. While not as dangerous as Group I, these lubricants require the same types of precautions and warnings. Group III and IV lubricants have been treated in such a way as to remove most aromatic compounds, but some components may still be of concern. Lastly, Group V lubricants are chemically engineered esters, polyglycols and silicone based. In this group, attention should be paid to any phosphate esters, as these compounds have the most potential to harm humans. Allergic reactions are also common for triphenyl-phosphate compounds.

Keep the appropriate PPE nearby, such as gloves, goggles, face shields or other safety gear. Practices that help to prevent spills, leaks or overuse should be employed, such as using a metered filter cart with quick disconnects for transferring or filling oils from storage. When sampling, use a pressure reducer if the oil is normally more than 7.03 kilogram/square centimeter.

HEALTH HAZARDS OF LUBRICANTS

Lubricant Type	Acute Toxicity	Dermatitis	Cancer
Mineral Oil	Some risk	Care required	Care required
Synthetic Hydrocarbon	Very slight	Care required	None reported
Diester and Polyolester	Slight	Care required	None reported
Phosphate Ester	Some risk	Care required	None reported
Silicone	Nontoxic	Little risk	None reported
Polyglycol	Believed to be low	Believed to be low	None reported
Chlorinated Diphenyl	Irritant vapor when hot	Care required	Same as mineral oil
Fluoroether	Toxic vapor when overheated	Not known	Not reported
Soluble Oil	Care required	Care required	Same as mineral oil
Grease	Very slight	Little risk	Little if any risk

Greases have a few unique handling precautions as well. These lubricants tend to settle in the tube when stored at lower temperatures and may need to be warmed before applying. Grease shouldn't be manually warmed above 23.9 degrees C and should never be warmed with any sort of flame. Also, never hold a grease gun coupler with your hand during application, and consider using grease guns with an installed pressure relief or avoiding pneumatic types for high-risk situations.

Worksite Monitoring

After any lubrication activity, such as draining, changeouts or filling, always recheck the worksite and equipment. Look for leaks or spills. It's possible a seal or cap wasn't properly reinstalled. Dust or debris may have settled on a small spot that wasn't noticeable during the maintenance task and now presents a potential hazard.

You may wish to schedule monitored lubrication evolutions. Observe how the lubrication activity is planned and carried out by the maintenance or operations personnel who deal with it each day. This allows for process improvement and helps shore up weak areas of safety training and practices. Include the lubricant storage area as part of any group cleaning of the plant to encourage personnel to become familiar with the equipment as well as how tools and lubricants should be used and stored. This not only serves to keep the area safe because equipment is properly maintained, but also ensures safety for other concerns like slips and trips.

Disposal

Used lubricants that are awaiting disposal are just as important to store properly as new oil, if not more so. Used oil may have contaminants or expired additives and present different chemical properties than new oil. Used lubricants often are mixed and may have different flash points than the base oil. Store used oil in a separate area from new oil and follow local HSE rules for combining different types of discarded oil or other products, such as oily rags.

For used filters, the best practice is to separate the metal portion for recycling, compress the media to remove the oil and dispose of the oil in a used-oil container. This reduces the fire risk from discarding the entire filter in the trash. Dispose of greasy or oily rags in proper disposal cans and don't allow them to accumulate or become a hazard. When cleaning equipment, use approved solvents or soaps and ensure any runoff goes to an approved environmental drain.

In short, store your lubricants correctly, handle them well, dispose of them properly, double-check your jobsite, follow all site-specific safety guidelines, and train to the standard by which you want the program to live. In most companies and worksites, safety is priority one. Performing lubrication tasks should be no different. Deliberately adopt a safety-first mindset to plan, execute and evaluate all the lubrication efforts at your plant. *ML*

About the Author

Daniel Rader is a Reliability Engineer at L3Harris Technologies, USA. A Certified Maintenance and Reliability Professional (CMRP) through the Society for Maintenance and Reliability Professionals (SMRP), he holds Level I Machine Lubrication Technician (MLT I) and Machine Lubricant Analyst (MLA I) certifications through the International Council for Machinery Lubrication (ICML).

Reliance and bp launch **'Jio-bp' partnership**

bp and Reliance Industries Limited (RIL) recently announced the start of their new Indian fuels and mobility joint venture, Reliance BP Mobility Limited (RBML). Operating under the "Jio-bp" brand, the joint venture aims to become a leading player in India's fuels and mobility markets. Under this partnership, Castrol lubricants will be available at the Jio-BP retail sites. It will leverage Reliance's presence across 21 states and its millions of consumers through the Jio digital platform. bp will bring its extensive global experience in high-quality differentiated fuels, lubricants, retail and advanced low carbon mobility solutions.

bp and RIL expect the venture to grow rapidly to help meet India's fast-growing demands for energy and mobility. India is expected to be the fastest-growing fuels market in the world over the next 20 years, with the number of passenger cars in the country estimated to grow almost six-fold over the period. RBML aims to expand from its current fuel retailing network of over 1,400 retail sites to up to 5,500 over the next five years. This rapid growth will require a four-fold increase in staff employed in service stations – growing from 20,000 to 80,000 in this period. The joint venture also aims to increase its presence from 30 to 45 airports in the coming years.

Commenting on the partnership Mukesh Ambani, Chairman and Managing Director of Reliance Industries Limited said: "Reliance is expanding on its strong and valued partnership with bp, to establish a pan-Indian presence in retail and aviation fuels. RBML will aim to be a leader in mobility and low carbon solutions, bringing cleaner and affordable options for Indian consumers with digital and technology being our key enablers."

Sandeep Sangwan, Managing Director, Castrol India Limited, said, "Castrol India is delighted to be a part of the Jio-bp network. We will offer a premium experience to our consumers, bringing innovative value-added solutions as together we look to transform the Indian mobility sector."

BASE OIL REPORT

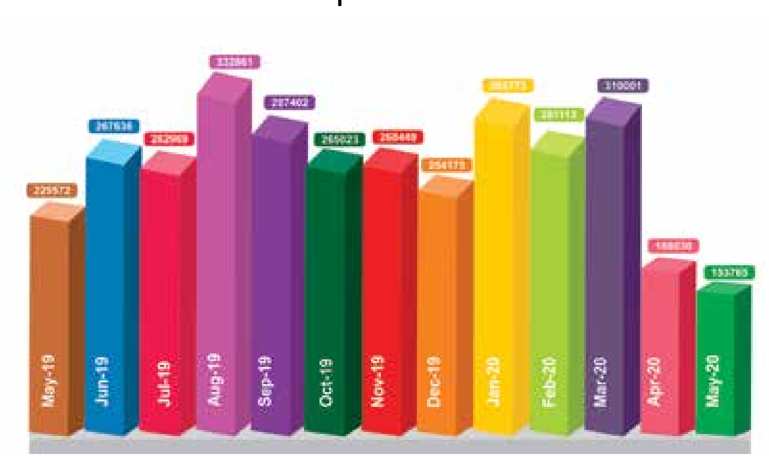
The world's biggest lockdown may have eased in India, but the country's oil refineries are finding it tough to pull off a complete recovery as fuel demand remains below pre-virus levels and stockpiles swell. Operations across 23 refineries nationwide were at 77 per cent of capacity in May, while that was an improvement from a low of 72 per cent in April, when stay-at-home orders decimated fuel demand and filled storage tanks to the brim, it was still well down on the 102 per cent recorded a year earlier. The amount of crude processed, also known as refinery throughput, was almost 25 per cent lower year-on-year last month.

The Indian domestic market Korean origin Group II plus N-60–70/150/500 prices at the current level are marginally down for lighter grades and heavier grades. As per conversation with domestic importers and traders prices for N – 70/ N- 150/ N - 500 grades and at the current level are quoted in the range of Rs. 39.40 – 39.55/40.65–40.80/44.40 – 44.55 per liter in bulk plus 18% GST as applicable. Discounts are being offered for sizeable quantity. The above mentioned prices are offered by a manufacturer who also offers the grades in the domestic market, while another importer trader is offering the grades cheaper by Rs.0.30 – 0.35 per liter on basic prices. Light Liquid Paraffin (IP) is priced at Rs.41.15 – 41.35 per liter in bulk and Heavy Liquid paraffin (IP) is Rs. 45.45 – 45.65 per liter in bulk respectively plus GST as applicable.

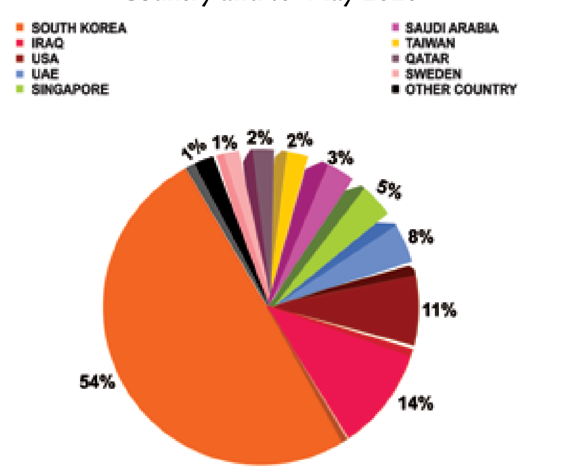
While in the month of May 2020, India imported 153765 MT of Base Oil, India imported the huge quantum in small shipments on different ports like 68649 MT (45%) into Mumbai, 24005 MT (16%) into Pipavav, 19537 MT (13%) into Kandla, 19086 MT (12%) into Hazira, 8996 MT (6%) into Chennai, 6512 MT (4%) into JNPT, 5228 MT (3%) into Mundra, 865 MT (1%) into Delhi and 886 MT (1%) into Other Ports.

Dhiren Shah
(Editor – In – Chief of Petrosil Group)
E-mail- dhiren@petrosil.com

Month wise import of Base Oil in India



Origin wise Base Oil import to India, Country and %- May 2020



Base Oil Group I & Group II CFR India prices:-

Month	Group I - SN 500 Iran Origin Base Oil CFR India Prices	Napthenic Base Oil HYGOLD L 500 US Origin CFR India Prices	N- 70 South Korea Origin Base Oil CFR India Prices	Bright Stock CFR India Prices
May 2020	USD 440 – 465 PMT	USD 515 – 530 PMT	USD 445 - 465 PMT	USD 620 – 640 PMT
June 2020	USD 425 – 440 PMT	USD 500 – 515 PMT	USD 440 - 450 PMT	USD 525 - 620 PMT
July 2020	USD 440 – 455 PMT	USD 515 - 530 PMT	USD 455 - 465 PMT	USD 540 - 595 PMT
	Since May 2020, prices have decreased by USD 10 PMT (2%) in July 2020.	Since May 2020, prices remained steady in July 2020.	Since May 2020, prices have increased by USD 5 PMT (1%) in July 2020.	Since May 2020, prices have dipped down by USD 65 PMT (10%) in July 2020.

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