SEPTEMBER - OCTOBER 2019

7th Anniversary Issue

Machinery Lubrication INDIA

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SEPTEMBER - OCTOBER 2019

Machinery Lubrication

INDIA

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Machinery Lubrication INDIA

EDITORIAL FEATURES

Publisher's Note

Our magazine Machinery Lubrication India has completed its 7 years with this issue. We've published over thousand articles. We always try to publish the most valuable articles and our dear readers take care of the rest, promoting the article throughout the social platforms and sharing it with colleagues' offline. Sometimes an article instigates new discussions on and beyond our Magazine. When the article gets published, we are absolutely confident that we are delivering value to our readers.

Anniversaries inevitably lead to introspection and retrospection. Since our very first issue (Sep-Oct, 2012), MLI has been devoted to providing value to Lubrication. Our stellar authors deserve credit for sharing their ideas and experiences.

Tailoring our publication to meet the reader's need – a mission we have always taken seriously. Keeping in mind the changing digital world, we took an initiative in 2017 to feature our magazine across all major digital stands. Readers can visit our website or refer e-book for easy reference of the past issues. We have introduced Face-to-Face section a few months back. This section contains interviews with persons who matters in the field of lubricants, lubrication and reliability and they share their first-hand knowledge with our readers. This has proved to be a popular and successful addition.

While it is tempting to dwell upon an editorial analysis of past successes, challenges, and mysteries, we are happy to announce our newest content. In honour of MLI 7th anniversary, we are introducing new sections like 'Great pioneers that inspire us' in which readers will get a chance to know about the life, achievements, research, writings of great pioneers who made a profound impact on industry & academia. Also being introduced is a section titled 'What if...?' in which readers will get to understand a particular situation and how the author handled or resolved the situation. We are also planning to introduce a section called 'Buyer's guide' - a comprehensive directory of companies who offer products and services within the machinery lubrication, reliability maintenance, and oil analysis industries. This shall be introduce soon. We hope our readers will equally appreciate these new sections.

We thank our readers for sending their feedback and sharing their experiences reading our magazine, you can read it in 'From the readers' section.

The reason why this magazine exists and why the articles are even being published is because of you, dear reader, keep reading and recommending Machinery Lubrication India to your friends and colleagues. Having such a large audience, we are fully aware of our responsibilities and we'll make sure to stay true to our values and principles in future.

We would like to thank each and every subscriber, advertiser, author and our partner (Noria Corporation, USA) for constant support and encouragement. A personal note to our advertisers, we thank you for advertising with us and more importantly, your confidence in us.

We are 16000 strong family of reliability professionals. We look forward to your contributions and insights.

We would like to thank our readers for the heartening response to our previous edition's cover story – "Who should be your Lubrication Technician" and other articles.

As always, we look forward to your valuable suggestions and feedback.

To the new beginnings and expanded potential, wishing you all Happy Navratri and Diwali.

Warm regards,

Udey Dhir

Jim Fitch | Noria Corporation

AS I SEE IT

UNDERSTANDING How Engines CONSUME OIL

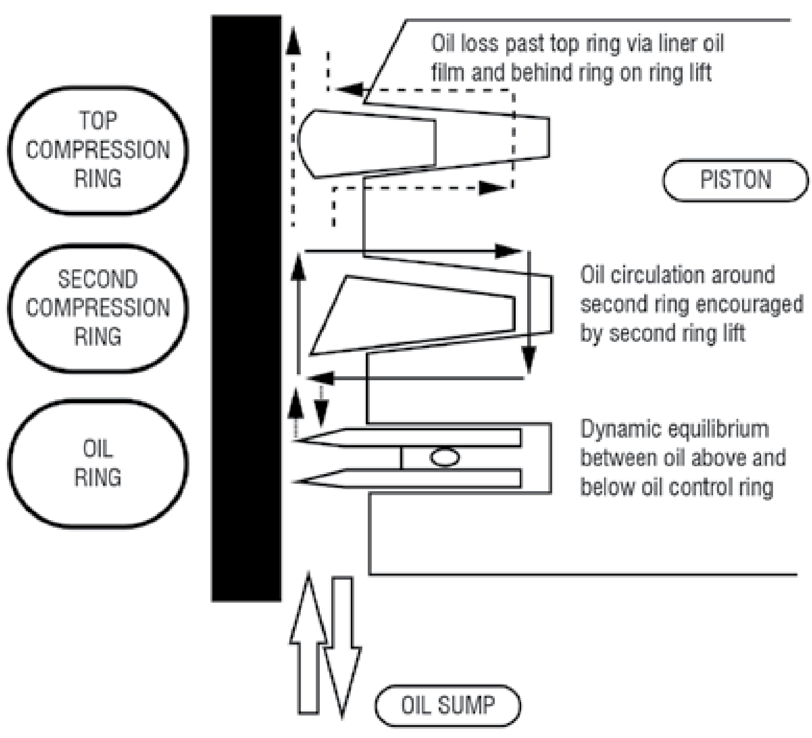
High consumption of engine oil is almost always a symptom or consequence of another condition of even greater importance. This article will address this issue from the standpoint of oil loss through combustion pathways (versus leakage). While the focus will be more on diesel engines used in industrial and commercial service, much of what will be discussed applies equally well to personal automobiles and natural gas engines.

By itself, oil consumption is a well-known source of harmful emissions to the atmosphere (see the sidebar on page 4). Unburned or partially burned oil is released through the exhaust path in the form of hydrocarbons and particulate contamination (soot). Additionally, motor oil anti-wear additives are known to poison or at least impair the performance of catalytic converters. The more oil consumed through the combustion chamber, the greater this poisoning risk/effect. This escalates the environmental impact further.

The causes of high oil consumption are many and complex. Because this consumption is symptomatic of other conditions, there is a need to be aware of changes in the oil consumption rate. These changes should be viewed in the context of other data and factors, including oil analysis, visual exhaust, engine service life (from last rebuild), boost pressures, running temperature, load/RACK, blow-by and operating conditions. Oil analysis will be discussed in terms of the correlation and meaning of common trends and how they might be useful for troubleshooting purposes.

Causes of High Oil Consumption

Understanding oil transport mechanisms is necessary to prevent oil



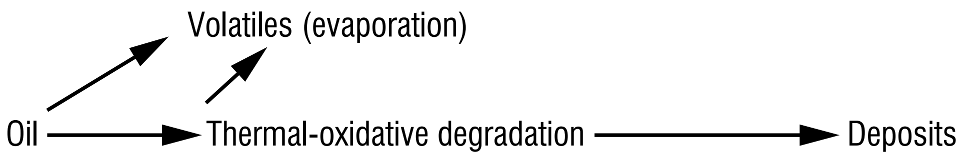


Figure 2. The sequence of piston ring-pack deposit formation

from going where it shouldn't. Loss of engine oil is influenced by the engine's design and the operating conditions. Oil consumption primarily occurs near or through the combustion chamber, either downward through valves or upward past the piston ring-pack.

Oil Mobility and Consumption Through Engine Valves

Oil collecting on the stems of intake valves is sucked into the combustion

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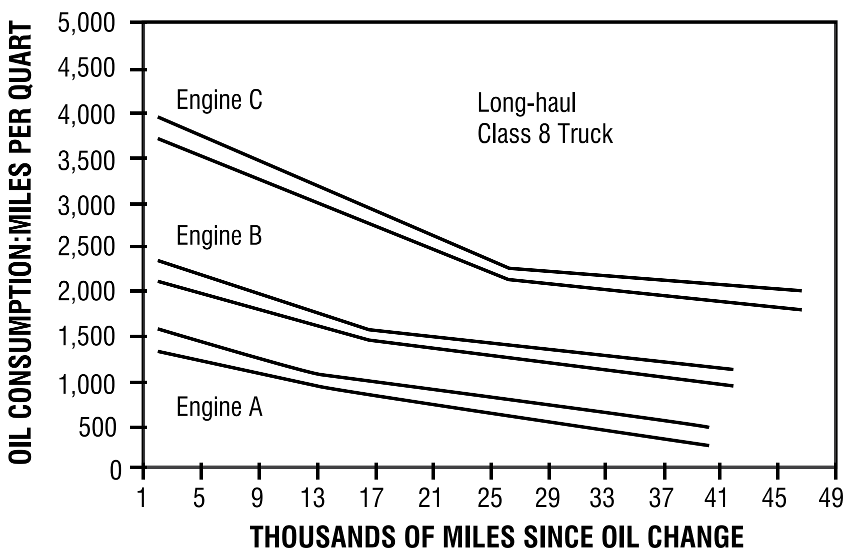


Figure 3. Effects of the oil change interval on miles per quart of oil (Ref. Carver, Exxon)

chamber during normal operation. Hot exhaust gases burn oil on stems of the exhaust valves. If there's too much clearance between the valve stems and guides, the engine will suck more oil down the guides and into the cylinders. This could be caused by valve guide wear and seals that are worn, cracked, missing, broken or improperly installed. The engine may still have good compression but will burn a lot of oil.

Oil Flow Through the Piston Ring-pack

Engine oil is designed to produce an oil film on the cylinder walls. While the oil control ring on the piston squeegees much of it off, a thin film will still remain. When the engine decelerates, high negative pressures suck oil in the combustion chamber and out the exhaust manifold.

The problem is more pronounced when rings or cylinders are badly worn or damaged, but it can also occur if the cylinders were not honed properly (out-of-round or surface finish defects) when the engine was built (or rebuilt) or if the rings were installed improperly.

Much of the oil that is transported through the piston ring-pack and along the liner usually occurs during the compression stroke. The oil control ring scrapes the oil from the cylinder wall. The scraped oil flows to the ring drain holes/cavities. Oil left behind on the cylinder wall is needed to lubricate the compression rings. Once oil moves past the compression rings, it is difficult for the oil to return to the sump. However, blow-by gases can provide a transport medium to help recycle the oil back to the sump (see Figure 1).

Piston Ring-pack Deposits and Movement

Piston ring-pack deposits can sharply reduce ring movement and flexing. Likewise, ring movement can greatly influence where deposits form and the

How Oil Consumption Influences Tailpipe Emissions and Health

As engines age and wear, they become greater consumers of crankcase oil. Solid contaminants combined with soot and other oil suspensions influence engine wear, deposits and oil economy (oil consumption rate). When oil is consumed, it enters the combustion chamber, burns with the fuel and is pushed out with exhaust gases as particles and volatile hydrocarbons.

Fresh new lubricants have more volatile light-end molecules and are more prone to hydrocarbon emissions. As the oil ages, the hydrocarbon emission levels off but can pick up again if the oil becomes contaminated with fuel (fuel dilution), such as from short run times or long idles. However, in general, the service life of the oil has no significant influence on carbon monoxide and nitric-oxide emissions.

The level of exhaust emissions can increase considerably over time, corresponding to engine wear and deposit formation. This leads not only to greater exhaust particulates but also to a higher percentage that are hydrocarbon, which is a byproduct of oil consumption. It has been observed that lubricating oil is a significant contributor to the particulate emissions signature as the engine ages, especially with diesel engines. The obvious strategy to control/reduce hydrocarbon emissions is to decrease oil consumption. This, in large part, is accomplished only by controlling combustion efficiency, wear and deposits (especially through good lubrication and filtration practices).

Nitrogen oxides (NOx) consist of nitric oxide (NO) and nitrogen dioxide (NO2). These ozone precursors also lead to smog when exposed to hydrocarbon gases and sunlight. As a health hazard, NOx can potentially cause irritation and damage to lung tissue as well as paralysis. Because of regulatory requirements and environmental protection pressures to lower both particulates and NO2, increased pressure has been placed on lubricant formulation, engine design and filter performance.

OIL ANALYSIS AND OTHER REPORTABLE CONDITIONS	WHAT IT COULD MEAN	WAYS IT CAN CAUSE HIGH OIL CONSUMPTION	WAYS HIGH OIL CONSUMPTION CAN CAUSE IT	WAYS IT CAN OCCUR CONCURRENT WITH HIGH OIL CONSUMPTION
Low base number/high acid number	High blow-by, water contamination, distressed base oil, high sulfur fuel	Corrosion of piston-ring-liner (PRL), piston ring-pack deposits	Low oil level prematurely depletes overbase detergents and antioxidants	High blow-by gas ingestion due to poor compression/combustion efficiency
High oil viscosity	High soot load, wrong oil, glycol in oil, hot oil, extended oil drain, oil oxidation	High ring float, piston ring-pack deposits	Fractional evaporative light-end oil loss	High blow-by (soot) due to poor compression/combustion efficiency
Low oil viscosity	Fuel dilution, wrong oil, VI improver shear	Evaporative light-end oil loss, PRL wear		Incomplete combustion and blow-by (fuel dilution)
High soot load	High blow-by, extended oil drain, exhaust gas recirculation (EGR), long idle, etc.	High ring float from elevated viscosity, piston ring-pack deposits, PRL wear	Low oil level concentrates soot	High blow-by (soot) due to poor compression/combustion efficiency
Low soot dispersancy	Water contamination, high soot load, fuel dilution, extended oil drain, coolant leak	Piston ring-pack deposits	Low oil level depletes dispersant prematurely	High blow-by (soot) due to poor compression/combustion efficiency, incomplete combustion and blow-by (fuel dilution)
Water contamination	Coolant leak, short intermittent operation, cold temperature	PRL corrosion		High blow-by and short intermittent operation
Sludge and oxide insolubles	Extended oil drain, base oil oxidation, poor dispersancy, depleted detergency	Piston ring-pack deposits, PRL wear	Low oil level raises sump temperature and prematurely depletes antioxidants	
Fuel dilution	High blow-by, PRL wear, extended oil drain, injector issues, overfueling/lugging	PRL wear and blow-by, premature base oil oxidation (piston-ring deposits)		Incomplete combustion and blow-by (fuel dilution)
Coolant (glycol) contamination	Coolant leaks from defective seals, cavitation, corrosion, damaged cooler core, head gasket leak, etc.	High ring float from elevated viscosity, PRL corrosion, PRL wear, piston ring-pack deposits		High blow-by gas ingestion due to poor compression/combustion efficiency
Dirty oil (silica) and other solid contaminants	Dirty air induction, defective oil filter, dirty fuel, dirty new/backup oil, wear and corrosion debris	PRL abrasive wear causes high oil consumption	High oil consumption carrying particles causes excessive PRL abrasive wear and more particles	High blow-by gas ingestion brings in induction air dirt and fuel dirt

lubricant motion (transport) within the ring-pack. This ring motion defines the residence time of the lubricant in the ring-pack, which in turn affects the rate of lubricant degradation and where deposits will form (see Figure 2). Ring-pack temperatures can range from 195-340 degrees C.

Collectively, these conditions can accelerate piston-ring-liner (PRL) wear, impair combustion efficiency, increase blow-by and reduce oil economy (more oil consumption). One way this happens is through carbon jacking. In this phenomenon, carbon buildup occurs in the ring grooves (fed by soot and oil degradation products). The corresponding ring movement restriction increases wear, blow-by and oil consumption with the rhythm of the piston.

Cylinder Wall Oil Evaporation

As much as 17 percent of total oil consumption is associated with liner wall evaporation. The more distorted (out-of-round) and rough (surface finish) the cylinder liner, the more oil film that will remain on the liner after the power stroke. High liner surface temperatures (80-300 degrees C) will cause a loss of this oil by misting and evaporation. Light oil molecules are more prone to evaporation. These light molecules are the first to deplete, and as a result, there is less evaporative loss toward the end of the lubricant's service interval.

Not all oils of the same viscosity are

equal from the standpoint of volatility (risk of evaporative loss). Some lubricants may exhibit as much as a 50-percent greater loss from volatility than others. This is influenced by the base oil's molecular weight distribution.

Of course, temperature plays a key role. A low liner temperature translates to a low evaporation rate. Liner temperature is influenced by load, combustion efficiency and cooling. Approximately 74 percent of vaporization occurs during intake and compression strokes (no speed effects have been found).

Blow-by from Ovaloid Cylinder Bores

Ovaloid cylinder bores are usually caused by machining issues as well as thermal and pressure distortions. Piston rings can conform to out-of-roundness cylinders to a certain extent. Still, reverse blow-by gases and oil mist can follow the pathway across these cylinder bore distortions by moving more easily against the ring's running face. Oil mist is carried with reverse blow-by gases into the combustion chamber and outward with the exhaust.

High Ring Float Conditions

Researchers have found that lower oil viscosity can reduce the oil control ring's "float" conditions. "Float" basically means there is too much film thickness between the oil control ring and the cylinder wall. Consequently, this excessive viscosity fights the ring's ability to squeegee (downscrape) the oil sufficiently from the cylinder wall and return it to the sump. As a result, too much oil is left on the cylinder wall that then can move toward the compression rings or remain adherent to the liner, increasing oil loss through misting and evaporation.

It is worth noting that too little viscosity induces a plethora of dangers as well. The optimum reference viscosity (not too low or high) is always desired. This "optimum" is pushed and pulled by numerous engine design and operation factors, including the desire to mitigate oil consumption.

Oil Change Interval Effect

Extended oil drains are an ever-growing trend. While there are clear advantages (lower oil change costs, higher productivity, environmental benefits, etc.), there are also engine life risks, fuel economy risks and oil economy penalties. A recent study on the effects of the oil change interval on miles per quart of oil is shown in Figure 3. Three different engines (Class 8, long-haul service) at different oil change intervals show a clear relationship between oil health and oil consumption. One can conclude that as oil ages, the effects of aging (high soot, loss of dispersancy, additive depletion, insolubles, viscosity-index shear, dirt load, etc.) impair the ability of the engine to retain the oil during service.

Oil Consumption Issues Revealed by Oil Analysis

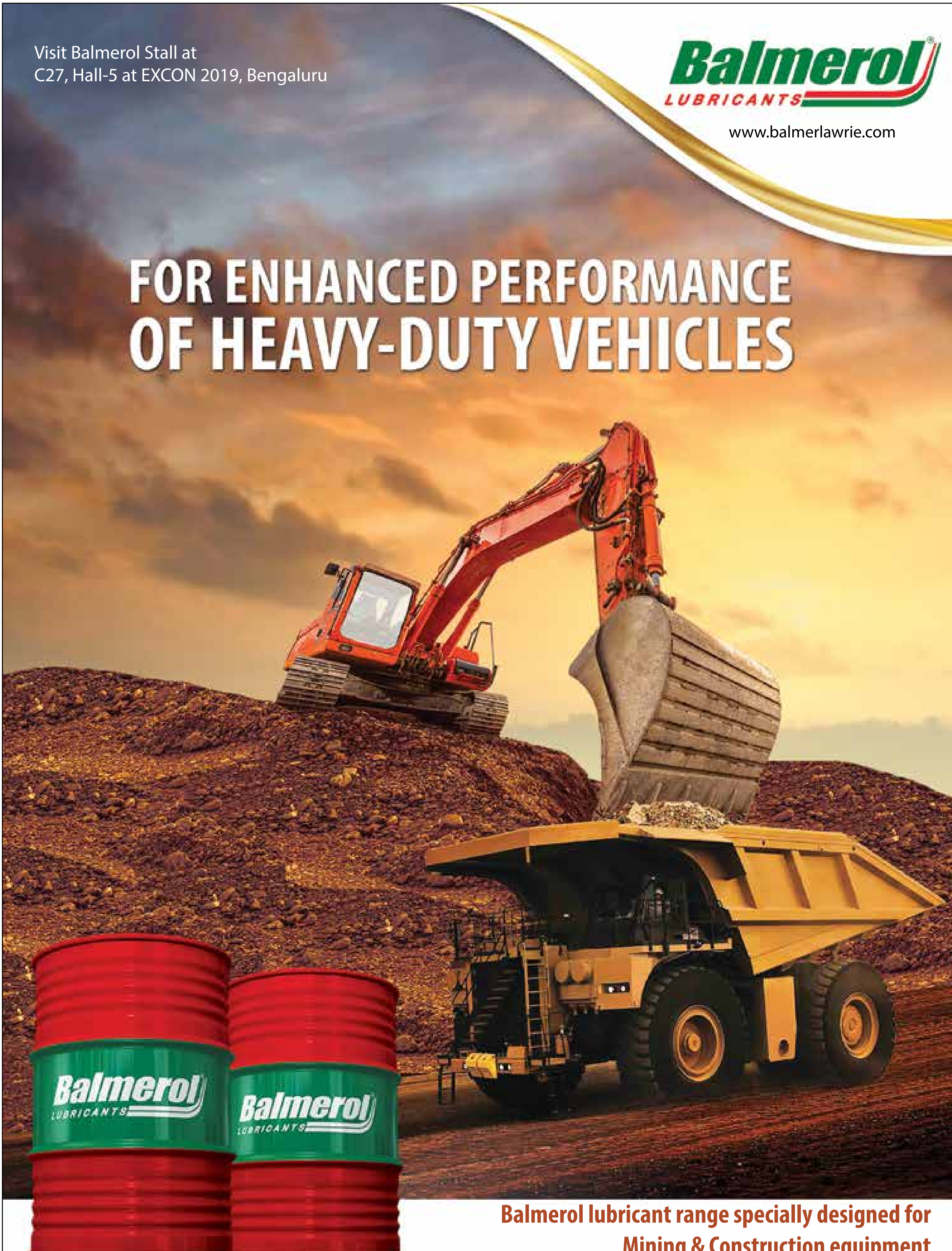
Monitoring oil levels and makeup rates offers a reliable indication of oil consumption and relative oil economy. If oil consumption is low, it can be assumed that while many things could be going wrong, they are not going wrong simply because engine oil consumption is within a normal and safe range. Therefore, it is logical to track oil levels and makeup oil consumed between scheduled oil changes.

The table above not only details how high oil consumption might accompany certain reportable oil analysis conditions but also provides examples of what these conditions may mean.

Understanding how engines consume oil is still a work in progress and is the subject of ongoing research by many organizations. It is important to slow down or arrest the problem as much as possible. Undoubtedly, much progress will be made in the years to come. In the meantime, it will be beneficial to use the current knowledge to its fullest extent. The strategies described in this article offer several plausible ways that this can be achieved.

About the Author

Jim Fitch has a wealth of "in the trenches" experience in lubrication, oil analysis, tribology and machinery failure investigations. Over the past two decades, he has presented hundreds of courses on these subjects. Jim has published more than 200 technical articles, papers and publications. He serves as a U.S. delegate to the ISO tribology and oil analysis working group. Since 2002, he has been director and 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 Alejandro Meza | Noria Corporation

Selecting LUBRICANTS Based on SPECIFICATIONS

Effective lubricant selection must strike a balance between quality, application and affordability. In order to achieve and maintain this balance, lubricant specifications should be created to serve as a guideline for what to purchase and how to use it. This article will discuss the necessary steps for creating lubricant specifications and how they can lead to sustained machine reliability.

What Are Lubricant Specifications?

Lubricant specifications are internal documents that contain the technical standards, performance requirements and industry approvals for every lubricant used in the facility or fleet. They may include information on product safety, proper disposal or alternative products available on the market. Among the lubricants typically found in these specifications are gear oils, turbine oils, hydraulic fluids, compressor oils, greases, solid lubricants, multi-purpose bearing oils, engine oils, cutting fluids, total-loss lubricants and others.

For small facilities or fleets, creating lubricant specifications can be a relatively simple exercise. However, the complexity often increases according to the facility's equipment diversity or the number of sites involved. The more complex the facilities or the higher the number of sites involved, the greater the value of creating specifications.

Elements of Lubricant Specifications

Depending on the needs of the plant or fleet, lubricant specifications may consist of the following elements:

Scope of Application

This defines the lubricant's general function or purpose as well as the material type. It also describes specific applications within the facility. For example, the lubricant defined by this specification is an API Group II mineral gear oil containing extreme-pressure additives. It is intended for use in gearboxes operating at temperatures up to 160 degrees F and which are lubricated by bath or circulation systems.

Physical and Chemical Properties

These are the intrinsic physical and chemical properties of the lubricant. Here it is important to identify not only the testing parameters used but also the expected test results. An ASTM or appropriate test method should also be referenced. Examples include ISO viscosity grades (ASTM D2422), minimum viscosity index (ASTM D2270), aniline point (ASTM D611), flash point (ASTM D92) and thickener type.

Performance Properties

These refer to bench and laboratory tests that the lubricant formula should pass at a minimum level. Examples include copper corrosion protection (ASTM D130), demulsibility (ASTM D1401) and dropping point (ASTM D2265).

Lubricant specifications are effective guidelines for selecting and using the right lubricants in the right applications.

Product Compatibility

This describes the concerns or characteristics of the product's compatibility with other lubricants as well as with synthetic materials existing in machine lubrication systems, such as seals and gaskets. This section may have added importance when the standard refers to synthetic lubricants or special formulas, since they may require specific procedures when switching to other lubricants. For example, this product is manufactured with polyalkylene glycol (polyglycol) base stock, which is not compatible with mineral oils and other synthetics such as polyalphaolephins.

Product Approvals

These are the lubricant approvals or endorsements required by the specific machine(s) in which the product is intended to be used. They may come from original equipment manufacturers (OEMs) or other industry organizations, such as the American Gear Manufacturers Association (AGMA), the National Lubricating Grease Institute (NLGI), etc. Please note that some lubricants may claim a certification or approval for certain technical standards or OEM specifications, while others may only "comply with" the standard or requirement but are not necessarily approved or certified. This may be particularly significant when complying with equipment warranty requirements.

INCOMING LUBRICANT QUALITY TEST - HYDRAULIC OIL ISO VG 68

TEST OR PROPERTY	BASE	MIN.	MAX.
Viscosity at 20°C (cSt)	Field viscometer	170	200
Acid number (mg KOH/g of oil)	Field test kit	1.1	1.4
Particle count	Particle counter / ISO 4406:99	- - -	19/16/13
Moisture analysis (ppm)	Calcium hydride kit	- - -	500

Potential Restrictions and Hazards

This section describes any undesired ingredients or product properties as well as toxicological or safety aspects to be considered when buying or handling the lubricant. For example, the product must not have mutagenic or carcinogenic compounds.

Lubricant Identification System

Every lubricant to be used in the plant should have a unique identification code to prevent mislabeling or misapplication. The classification should be independent of the brand name. In a proper identification system, every product will have unique visual and written codes. For example, a hydraulic oil may have a square lube identification tag, while a grease may have a round tag.

Quality Control at Reception

This element specifies the tests to be conducted on lubricants entering the facility in order to verify product quality. Here it is necessary to define laboratory or field tests as well as the acceptable results or limits. ASTM methods, test equipment, field test kits and product inspections may be referenced. See the example below.

Supplier Requirements

This section identifies the requirements for the lubricant supplier relating to product quality. For example, the supplier should be ISO 9000-certified, or every batch of lubricant should be sent with a certificate of analysis. The lubricant supplier approval process can provide more detailed information about the supplier.

Lubricant Disposal

This element provides general or specific requirements for lubricant disposal based on the product type, formula, contaminants and lubricant volumes. These requirements should be defined according to local regulations and corporate policies.

53%

of lubrication professionals say their plant has created lubricant specifications to aid in the lubricant selection process, according to a recent poll at MachineryLubrication.com

Supporting Information

This information supplements the specifications' technical descriptions. It may include a glossary of terms, ISO viscosity grades, NLGI classifications and ASTM standards.

Creating Lubricant Specifications

The process of creating lubricant specifications should first begin by developing or updating the database of machines, lubrication points and lubricants in the plant or fleet. Product recommendations will come primarily from OEMs, lubricant suppliers, consulting companies or internal experience. Other technical references may also be consulted, such as the AGMA, ISO, NLGI and others. For critical machines, additional validation may be needed to ensure the selected lubricant fulfills the lubrication requirements based on the equipment's current operating conditions.

Once the database of lubricants and lubrication points has been completed, it is time to consider product consolidation. The goal is to minimize the number of lubricants used in the plant while still maintaining appropriate lubrication of all machines. The consolidation process should help identify products that are equivalent, lubricants that have similar specifications, machines that can utilize multi-purpose lubricants and when it is practical to use a higher quality lubricant.

At this point, a consolidated list of lubricants can be generated, including all equipment applications for each product. The next step is to create specifications for every lubricant or lubricant family. Whenever possible, the information should be categorized by product family, i.e., all lubricants that have similar properties but differ only by viscosity grade. If there is a single lubricant with special properties for a specific application, a lubricant specification document should be produced just for it.

Creating these specifications may involve several different departments such as engineering, maintenance and purchasing. Lubrication knowledge will be required as well as access to equipment manuals and lubricant requirements. Expert outsourcing support can be employed when internal resources are limited.

Keep in mind that the specifications as well as the database of lubricants and lubrication points must be updated whenever there is an equipment change or new product option. An overall review of the system should also be conducted on a yearly basis. This system may be part of an overall lubricant selection initiative as illustrated on the left.

In conclusion, lubricant specifications are effective guidelines for selecting and using the right lubricants in the right applications. These documents not only can help ensure quality products are acquired at the best possible price, but they can also provide guidance to lubricant suppliers, simplify lubricant handling and application, improve lubricant management, and reduce costs at different levels of your organization. ■

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 select the proper lubricants for your machinery.

Michael Brown | Noria Corporation

UNDERSTANDING the Differences in ENGINE OILS

Contrary to popular belief, there are major differences between passenger car motor oil (PCMO) and heavy-duty diesel oil. The main distinction is in the additive packages. PCMO has lower detergent and anti-wear (AW) additive levels. The AW additive alone can play havoc with components like catalytic converters. This is why you do not want to mix up these engine oils or use one in place of the other.

Additive Packages and Catalytic Converters

A catalytic converter is the large metal box bolted to the underside of your car. It has two pipes coming out of it, with one for the "input" and the other for the "output." The converter's input pipe is connected to the engine and brings in hot, polluted fumes from the engine's cylinder head. The output pipe is attached to the tailpipe. As gases from the engine fumes move over the catalyst, chemical reactions occur, breaking apart (cracking) the pollutant gases and converting them into other gases that are safe enough to blow harmlessly into the air.

Typically, there are two catalysts in a catalytic converter. One tackles nitrogen-oxide pollution using a chemical reaction called reduction (removing oxygen). This breaks up nitrogen oxides into nitrogen and oxygen gases, which are essentially harmless because they already exist naturally in the air. The other catalyst works by an opposite chemical process called oxidation (adding oxygen) and turns carbon monoxide into carbon dioxide. Another oxidation reaction converts unburned hydrocarbons in the exhaust into carbon dioxide and water. In effect, three different chemical reactions are occurring at the same time. After the catalyst has done its job, what emerges from the exhaust is mostly nitrogen, oxygen, carbon dioxide and water (in the form of steam).

Some of the byproducts of combustion, including lead, zinc, phosphorus and

> "For engine oils, the selected viscosity must allow the oil to be pumpable at the lowest startup temperature the vehicle will experience while still protecting components at in-service temperatures."

sulfur, can severely cripple the converter's ability to perform its job. Therein lies the first major difference between PCMO and heavy-duty diesel oil. Diesel engine oils have a higher anti-wear load in the form of zinc dialkyldithiophosphate (ZDDP). Catalytic converters in diesel systems are designed to handle this additive, but gasoline systems are not. This is one of the main reasons you don't want to use diesel engine oil in your gasoline engine.

Effects of Switching Engine Oils

Viscosity is the single most important property of a lubricant. For engine oils, the selected viscosity must allow the oil to be pumpable at the lowest startup temperature the vehicle will experience while still protecting components at in-service temperatures.

Generally, diesel engine oil has a higher viscosity. If you were to put this higher viscosity oil in a gasoline engine, several problems might arise. The first issue would be heat generation from internal fluid friction. Heat affects the life of the oil in a negative way. For every 10 degrees C the temperature of the oil is raised, you cut the life of the oil in half.

Another problem with this higher viscosity oil is its low-temperature pumpability. During cold starts, the oil may be very thick and difficult for the oil pump to deliver to vital engine components like the lifter valley. This lack of oil at startup will lead to premature wear, as the components will interact without the benefit of lubrication until the engine temperature starts to increase.

36%

of lubrication professionals cannot distinguish passenger car motor oil from heavy-duty diesel engine oil, according to a recent survey at MachineryLubrication.com

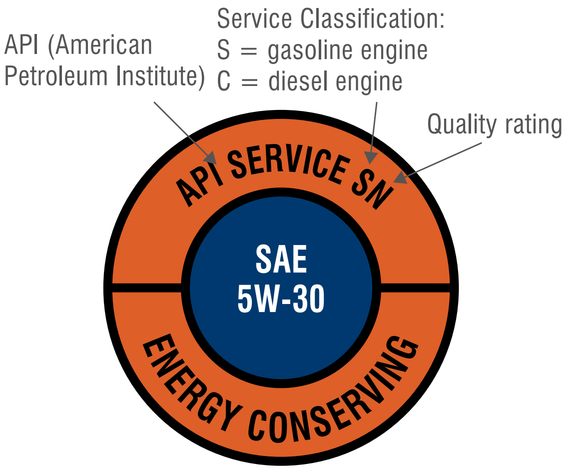
Additive Effects on the Engine

Diesel engine oil has more additives per volume. The most prevalent are overbase detergent additives. These additives have several functions, but the primary ones are to neutralize acids and clean the oil in the sump. Diesel engines create a great deal more soot and combustion byproducts. Through blow-by, these find their way into the crankcase, forcing the oil to cope with them. When this extra additive load is put into a gasoline engine, the effects can be devastating to performance. The detergent will work as designed and will try to clean the cylinder walls. This can have an adverse effect on the seal between the rings and liner, resulting in lost compression and efficiency.

Reading Oil Labels

So how do you know if an oil has been formulated for a gasoline or diesel engine, or even the particular year the vehicle was made? When reading the oil's label, look for the American Petroleum Institute (API) donut. In the top section of this donut will be the service designation. This designation will start with either an "S" (service or spark ignition) for gasoline engines or a "C" (commercial or compression ignition) for diesel engines. See the example on page 56.

Other organizations have their own codes for the types of oils used in gasoline and diesel engines. They also align with the API's standards. These include the International Lubricant Standardization and Approval Committee (ILSAC) and the Association of European Automotive Manufacturers (ACEA). API and ILSAC are based in the United States, while ACEA is in Europe. These organizations help to specify automotive and diesel engine oils throughout the world.



Donut Symbol

Other Considerations

There are many things to consider when choosing an engine oil for your car, including the weather conditions in which the vehicle will be operating. For instance, in the middle of winter, you want to select an oil that will stay sufficiently viscus to ensure it flows to the engine's vital components. The oil's viscosity is another critical factor for ensuring the engine's moving parts are sufficiently separated to minimize wear. The oil's additive package is also important. Too high anti-wear additive levels can cause your catalytic converters to clog prematurely, while excessive detergent additives can lead to piston blow-by, loss of compression and premature oil degradation. If you have doubts as to the type of oil you should be using in your vehicle, be sure to follow the manufacturer's recommendations.

About the Author

Michael Brown is an associate technical consultant with Noria Corporation. He has more than 20 years of experience in heavy manufacturing and holds Machine Lubrication Technician Level I and Machine Lubricant Analyst Level I certifications through the International Council for Machinery Lubrication. Contact Michael at mbrown@noria.com.

	GASOLINE		DIESEL	
Standard	From	To	From	To
API	SA	SN	CA	CJ-4
ILSAC	GF-1	GF-5	N/A	N/A
ACEA	A1 (A4)	A5	B1	B5

Cross-reference for API, ILSAC and ACEA

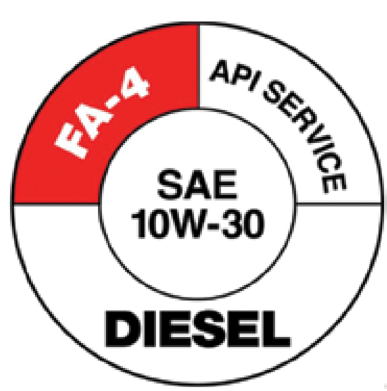
API Introduces New Diesel Engine Oil Standards

The American Petroleum Institute (API) is introducing two new standards to take into account the latest technology in diesel engines. API CK-4 and FA-4 will first appear in the API service symbol donut on Dec. 1, 2016. These new service categories improve upon existing standards by providing enhanced protection against oil oxidation, engine wear, particulate filter blocking, piston deposits, and degradation of low- and high-temperature properties.

API CK-4 describes oils for use in high-speed, four-stroke-cycle diesel engines designed to meet 2017 model-year on-highway and Tier-4 non-road exhaust-emission standards as well as for previous model-year diesel engines. These oils are formulated for use in all applications with diesel fuels ranging in sulfur content up to 500 parts per million (ppm). However, the use of these oils with greater than 15 ppm sulfur fuel may impact exhaust aftertreatment system durability and/or oil drain intervals.

CK-4 oils exceed the performance criteria of API CJ-4, CI-4 with CI-4 Plus, CI-4, and CH-4, and can effectively lubricate engines calling for those API service categories. When using CK-4 oil with higher than 15 ppm sulfur fuel, consult the engine manufacturer for service interval recommendations. Most truck manufacturers recommending API-licensed CJ-4 engine oils will likely recommend truck owners start using licensed API CK-4 oils as soon as they are available.

The API FA-4 standard designates certain lower viscosity oils specifically formulated for use in select high-speed, four-stroke-cycle diesel engines designed to meet 2017 model-year on-highway greenhouse gas (GHG) emission standards. Some engine manufacturers might recommend FA-4 oils for their previous model-year vehicles, but it is more likely that manufacturers will recommend the oils starting with the 2017 model-year engines. These oils are neither interchangeable nor backward compatible with API CK-4, CJ-4, CI-4 with CI-4 Plus, CI-4 or CH-4 oils. Therefore, you should heed the engine manufacturer's advice for API FA-4 oils.



New 2017 API FA-4 donut

GREAT PIONEERS
THAT INSPIRE US

At Machinery Lubrication India, we constantly endeavor to enhance the content of our publication. Keeping in mind the interest of our subscribers, we are starting a special section 'Great Pioneers that inspire us'.

We have great pioneers who made a profound impact on industry and academia with their works, inventions, research and writings. One of them was Dr Hans Peter Jost. He needs no introduction to the professionals and academicians in the field of tribology and lubrication.

In this section, we will look at the life, the challenges and the achievements of Dr Jost, one of the most outstanding pioneers of all time.

Although the discipline of tribology, the study of friction, wear and lubrication, was only named in the 1960s, it had been a crucial aspect of human endeavour for millennia. An Egyptian bas-relief showed workers dragging a statue on a wooden sled while another man was pouring liquid on to the track ahead of it to smooth its progress. He was the world's first recorded tribologist, Hans Peter Jost.

Professor Peter Jost was pre-eminent in tribology (the study of friction), which he conceived, developed, applied and promoted with exceptional vigour during his years of career. A distinguished contributor to professional and public life, there can hardly be another British engineer with more worldwide honours and decorations, nor anyone more active in promoting engineering.

We cannot deny that he made the world spin a little more smoothly. However, separate German, USA, Canadian, Chinese, UK and Japanese surveys, based on his ground breaking 1966 study for the Department of Education and Science and his subsequent papers, have concluded that tribology, the interdisciplinary science and engineering of interacting surfaces in relative motion, mitigates costly friction and wear effects to the enormous extent of 1.1% to 1.4% of gross domestic product.

TIMELINE

- **1921** Born on January 25
- **1943** Started his career as Planning Engineer at D Napier & Son Ltd.
- **1948** Got married to Margaret Kadesh
- **1950** Became general manager of international lubricants company Trier Bros
- **1969** Honoured by the heads of state of France, Germany, Poland, Austria and Japan

Professor Peter Jost CBE HonFREng

INVENTOR OF THE TERM 'TRIBOLOGY'

Engineer known as the father of tribology — the study of friction — who saved industry a fortune by avoiding wear and tear

Peter Jost coined the term "tribology" (from the Greek word "tribo" – I rub) to describe the science of friction, wear, and lubrication – giving birth to a new engineering discipline.

THE BEGINNINGS

Hans Peter Jost studied at Liverpool Technical College and Manchester College of Technology where his interest began in engineering. He began his career as an apprentice at Associated Metal Works, Glasgow, and Napier and Sons in Liverpool, winning the Sir John Larking Medal for a paper on Measurement of Surface Finish.

General Manager of international lubricants company Trier Bros at 29, he had developed an innovative steam machinery lubrication method. The oil-free aqueous colloidal graphite lubrication system saved energy and water by preventing the boiler tubes scaling up, which had often caused them to burst in the past. British Petroleum adopted the new system at its five new refineries, as did Shell Tankers and the lubrication system became essential until reciprocating steam plant became obsolete. By 1960, Jost had become lubrication consultant to Richard Thomas and Baldwins.

BIG ACHIEVEMENTS

Sixty years after he launched a whole new field of engineering, Dr Peter Jost was honoured with one of the Royal Academy of Engineering's top accolades – the Sustained Achievement Award – for his vision and achievements in tribology, the science and engineering of interacting moving surfaces. What might appear to be mundane issues of friction and lubrication are now understood to have applications way beyond engineering, from medicine and dentistry to nano technology.

One of Dr Jost's companies, Centralube, designed sophisticated, mission-critical engineering lubrication and allied systems for steel mills, refineries, space vehicles and forges, and for ships such as the Class T45 Destroyers and the new aircraft carriers.

Dr Jost's influential advice to the UK government included the very significant 1966 DES Jost Report, which demonstrated that friction and avoidable wear were costing the UK huge sums of money every year and resulted in the UK setting up several national centres for tribology.

Jost served as a director and chairman of several technology and engineering companies including the solid lubricants company K S Paul, and Engineering & General Equipment. He was an honorary fellow of the Institution of Engineering and Technology, the Institution of Mechanical Engineers and of the Institute of Materials.

A MAN OF MANY FIRSTS

Centralube's ferrous industry interests led to Jost becoming the world's first steelworks lubrication engineering consultant. He resolved many design problems at Richard Thomas & Baldwin's new Llanwern integrated steelworks and his lubricant specification changes and integrated lubrication distribution systems resulted in substantial operational improvements and cost savings.

In 1966, Jost published a report, commissioned by the government, which showed (for the first time) that the problems of lubrication in engineering were mainly problems of design. Their solutions, Jost argued,

1992 Became the first honorary foreign member of the Russia Academy of Engineering

2000 Became first Millennium honorary science doctorate

2009 Co-launched the concept of Green Tribology, paving the way for the first Green Tribology World Congress

2013 Honoured with one of the Royal Academy of Engineering's top accolades–the Sustained Achievement Award

2016 Died on 7 June at the age of 95 needed a range of skills from scientific disciplines other than mechanical engineering – including chemistry and materials science, solid body mechanics and physics. By applying tribology to machine design, Jost and his team calculated that British industry could save £500 million a year as a result of fewer breakdowns causing low production; lower energy consumption; reduced maintenance costs; and longer machine life.

Appointed CBE in 1969, Jost was honoured by the heads of state of France, Germany, Poland, Austria and Japan, and in 1992 he became the first honorary foreign member of the Russia Academy of Engineering. He held two honorary professorships and 11 honorary doctorates including, in January 2000, the first Millennium honorary science doctorate.

Jost report led to the setting up of several national tribology centres in Britain, though initially it was Britain's competitors who took the ball and ran with it. By the late 1980s Britain was lagging behind the US, Germany and Japan.

A press release from five learned societies announcing the creation of a UK Tribology Network to promote best practice observed that while Britain has a strong academic and industrial tribology base, "due to the fragmentation of activity within the UK the impact on reducing the very high cost (circa 1.4 per cent of GDP) of uncontrolled friction, lubrication, surface selection and wear-control within industry has been limited."

Although tribology was a relatively new science, Jost argued that the principles behind it had been around for centuries. "If in the days of Newton, bananas had been available and Newton had slipped on one of them, the laws of tribology would have been enunciated by him there and then," he told an interviewer. "Instead, it is said that an apple fell on him while he was asleep under the tree, and the laws of gravity resulted from there." In 2009, he co-launched the concept of Green Tribology, paving the way for the first Green Tribology World Congress with 2,000 attendees.

He elected as an honorary fellow at International Tribology Council and World Tribology Congress but sadly passed away before he could formally take up his fellowship. Peter Jost died on 7 June 2016 and left behind his wife Margaret and daughters Jennifer and Gillian. Peter was truly a kind and great man who is been sorely missed. ■

DID YOU KNOW...?

- Professor Jost authored more than 150 publications and had been Honorary Editor of Springer's peer-reviewed international journal, Friction.
- He had been honoured in 18 countries and received state recognition from six. He held Honorary Fellowships from 11 national professional engineering or tribological bodies.
- He was a member of the Parliamentary and Scientific Committee for over 25 years and served many technology committees.
- He had received the Royal Academy of Engineering Sustained Achievement Award in 2013 and had been awarded honorary doctorates at six UK and five international universities.
- He served numerous industry councils, and until his death he was the president of International Tribology Council and a life member of the council of the Parliamentary & Scientific Committee.

"In an age in which new technologies are cascading upon us at an increasing pace, recognition of the effects of multi disciplinary generic technologies, such as tribology, is essential to evolve sound policies for tomorrow's engineering. I am proud to be only the ninth recipient of this honour since its inception, looking upon it as a manifestation that the Academy is a forward looking body in our rapidly changing world."

- Dr. Peter Jost

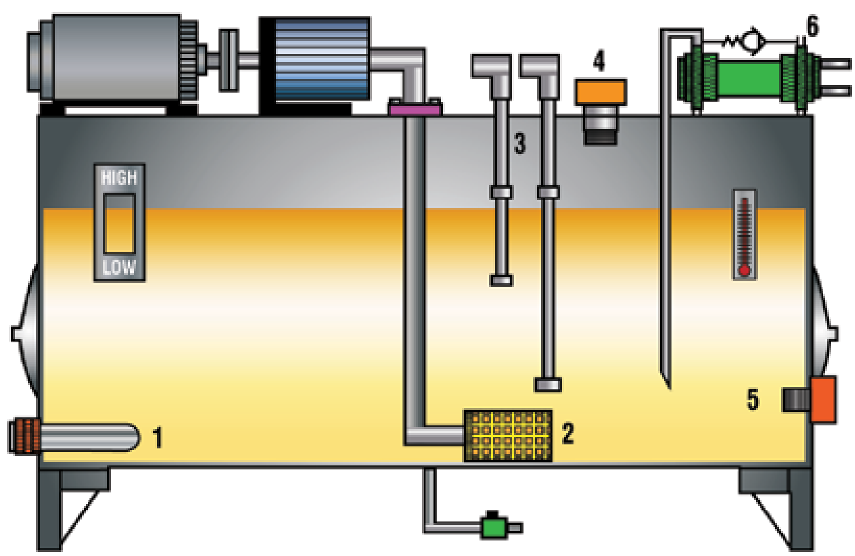
"Applying tribology saves energy and improves the reliability of systems like engines, gearboxes, human joint implants, manufacturing processes and ship propulsion. Having articulated the concept, Peter comprehensively practised and promoted it. Sixty years on, his influence on world-wide adoption is unabated."

- Dr Ian Nussey OBE FREng
(The one who nominated Dr Jost for the award)

Al Smiley | GPM Hydraulic Consulting

Simple Tests to Increase the Reliability of Your Hydraulic Systems

Often the only tests and actions performed on a hydraulic system involve changing the filters, sampling the oil and checking the oil level. As long as the system is operating, the mentality of "if it ain't broke don't fix it" frequently prevails. However, on any given system in your plant, you should perform 15 to 20 regular reliability tests while the system is operating. There are also several checks and procedures that should be completed during shutdowns or down days. The following preventive maintenance and reliability tests can help improve the efficiency and operation of your hydraulic systems and machines.



An example of an oil reservoir in a hydraulic system

1 = Heater thermostat
2 = Suction strainer
3 = Switch settings
4 = Breather cap
5 = High-temperature switch
6 = Heat exchanger

Check the Oil Reservoir

A good time to check the oil reservoir is when your plant or system is down. Maintenance mechanics and electricians usually chuckle when I tell them that the reservoir should be cleaned at least once a year. One mechanic at a large wood products plant told me that the reservoir on one system hadn't been cleaned since the mill started up 17 years ago.

Other than oil storage, the two main purposes of the reservoir are to dissipate heat and to allow contaminants to settle. If the reservoir is not cleaned, not only will its ability to dissipate heat be diminished, but it will act as a heat sink. Temperatures can easily soar well above the maximum recommended level of 140 degrees F. Oil will then start breaking down, leading to sludge and varnish in the system. If the contaminants are not removed from the reservoir, they will be drawn into the pump, causing premature failure of the system components.

Many reservoirs contain a suction strainer to keep large particles from entering the pump. Most suction strainers have a 74-micron rating, whereas the tolerances inside pumps and valves are typically 3 to 8 microns. Always use a lint-free cloth when cleaning a reservoir. If a solvent is

A flushing unit can be used to remove solid contaminants and water from the oil.

employed, be sure it is recommended for hydraulic systems. Even small amounts of the wrong solvent can impair certain additives.

System Cleaning and Flushing

When oil is removed from the reservoir, it should be filtered going into a storage tank with a flushing and filtering unit, which can remove solid contaminants and water. Use a quality, high-capture-efficiency filter (ISO 16889) that matches the target cleanliness level of the system. Unless the oil is severely degraded, it is not necessary or even desirable to change it.

After the reservoir is cleaned, run the oil through the filters while refilling. The entire system should then be flushed to clean the oil in the lines to the valves and actuators.

Oil purity is shown for a system before it was flushed (left) and then after one, four and 16 hours. This particular system had high water content prior to flushing.

System flushing is done by connecting the inlet and outlet lines of the cylinders and motors. If possible, electrically or manually actuate the directional valves to allow the fluid to recirculate through the piping. If this is not possible, bypass the directional valves by connecting the pressure and tank lines to the outlet lines of the actuators. Utilize the machine's existing pump to recirculate oil through the lines. Connect a high-velocity flushing unit so it recirculates oil in the reservoir through the filters during the flushing process. Allow the system to run for as long as possible.

Verify the Reservoir Heater Setting

Many times the heater is disconnected during the summertime or may have been omitted from the reservoir when it was initially built. Check the heater thermostat on the reservoir to confirm that it will turn on at a minimum of 70 degrees F. If the pump is mounted on top of the reservoir and the oil temperature drops below approximately 60 degrees F, then some cavitation of the pump may occur.

Adjust Oil Level Switches

Most reservoirs utilize two switch settings — warning and shutdown. The problem is that the difference between these two levels may be several hundred gallons of oil. By eliminating the warning switch and setting the shutdown at a higher level, oil loss will be minimal if a hose ruptures.

Check the Breather Cap

The breather cap is usually the most neglected component on the reservoir. Verify that the breather cap filter has a capture efficiency that matches the target fluid cleanliness. This is the first line of defense for contaminants entering the tank. Depending on the location, the breather cap may need to be changed a couple of times a year. Many breathers have a mechanical indicator that will provide a visual indication when the element is dirty. Other options include pressurizing the reservoir with an internal bladder or using a moisture-removal type of breather. Remember that money spent upgrading your breather cap is never wasted.

By performing these tests, your systems will operate safer and at maximum efficiency while reducing unexpected downtime.

Set High-temperature Switch

Mineral oil will begin breaking down at 140 degrees F, but many systems will not shut down the unit until the oil temperature reaches 160 degrees F. Hydraulic systems are designed to operate below 140 degrees F. For every 15 degrees F that the oil increases above 140 degrees F, the life of the oil will be cut in half. If the oil temperature rises above that level, then a problem exists in the system. This could be caused by a cooler malfunction or excessive bypassing at the pump. Set the high-temperature switch at 140 degrees F to shut off the pump, preventing oil breakdown.

Heat Exchanger Flushing and Cleaning

In a shell-and-tube type of heat exchanger, oil flows over the tubes. Water flow is ported through the tubes in the opposite direction. The heat in the oil is transferred from the oil to the water. To achieve the most efficient heat transfer, the water flow should be 25 percent of the oil flow. The water flow can be controlled by manual valves, a water-modulating valve or an electrical solenoid valve. Circulating hot wash oil or light distillate through the tube or shell side can effectively remove sludge or similar soft deposits. Soft salt deposits may be washed out by circulating hot, fresh water. A mild alkaline solution such as Oakite or a 1.5-percent solution of sodium hydroxide or nitric acid can be used. The tubes should be flushed in the opposite direction that the oil normally flows.

If an air cooler is employed, verify that the cooler fan is turned on at approximately 120 degrees F and turned off at about 105 degrees F. Keep the fins clean so daylight can be seen through them. If necessary, combs should be utilized to straighten the fins on the unit. When cleaning the fins with an air hose, care should be taken so as not to damage them.

Pump Testing

On variable-volume pumps, check the flow out of the case drain line by porting the line into a container and timing it. This test should be made with the outlet pressure at the maximum level. It is not recommended that the line be held during this test. Secure the line to the container prior to starting the pump. The normal case flow is 1-5 percent of the maximum pump volume. Vane pumps usually bypass more than piston-type pumps. If 10 percent of the maximum volume flows out of the case drain line, then the pump should be changed. An excellent method of monitoring the case drain flow while operating is to permanently install a flow meter in the case drain line.

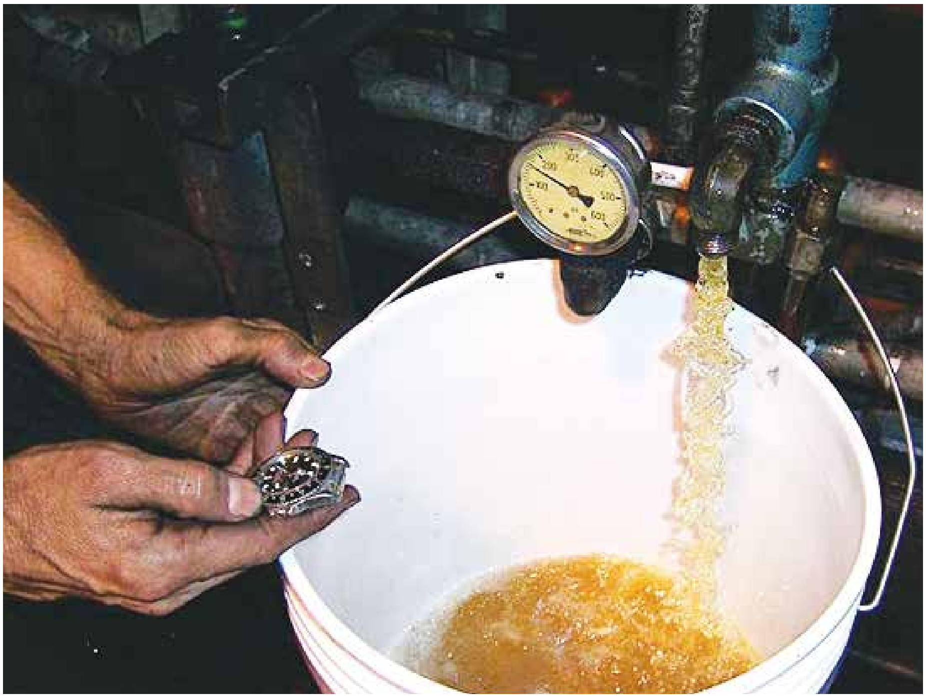
Fixed-displacement pumps can be tested by checking the flow through the relief valve. Turn on the pump and record the flow out of the relief valve tank line for one minute. Next, reduce the setting of the relief valve to its minimum setting. There should be less than a 10-percent difference in flow rates between the two tests. If a pump is badly worn, the flow will be considerably less at the highest pressure.

Accumulator Testing

An accumulator that is used for volume should be pre-charged with dry nitrogen to one-half to two-thirds the pump's compensator setting. When the hydraulic system is turned off, a charging rig with a gauge can be utilized to check the pre-charge level.
To confirm an accumulator is operating properly, check the side of the shell with a temperature gun or infrared camera. The bottom half should be hotter than the top half. If heat is only indicated at the bottom, the accumulator may be overcharged. If there is no heat, the bladder may have ruptured, the piston seals may be bad, the pre-charge may be above the compensator setting or all the nitrogen may have leaked out. If heat is felt all the way to the top, the accumulator is undercharged.

Another check that can be made is to watch the system pressure gauge while the system is operating. The pressure should not normally drop more than 100-500 pounds per square inch (PSI) when the accumulator is properly pre-charged.

If piston accumulators are used, the charging rig should be installed when the system is down and the oil bled off the top of the piston. With the pump on and the bleed valve open, there should be little or no flow out of the bleed



Test a fixed-displacement pump by turning on the pump and recording the flow out of the relief valve tank line for one minute.

valve. Care should be taken so all personnel are away from the bleed valve prior to turning on the pump. If there is continuous flow, the piston seals or barrel may be worn. If no flow exists, recharge the accumulator to the proper dry nitrogen level.

Check Hoses

Check all system hoses for the proper length and wear. Hoses rarely burst due to the rated working pressure being exceeded but rather because of a poor crimp or rubbing on a beam, another hose, etc. Hose sleeves are available from a variety of manufacturers if rubbing cannot be avoided. Hoses generally should not exceed 4 feet in length unless they move with the machine.

Also, examine the system piping to verify that a hose is installed prior to connecting to a valve bank or cylinder. The hose will absorb the hydraulic shock generated when the oil is rapidly deadheaded. One exception to this rule is that hard piping should be used when connecting to a vertical or suspended type of load. Pilot-operated check valves and counterbalance valves can be employed to hold the load in the raised position.

Inspect Clamps

Inspect system clamps to confirm they are the correct type for hydraulic lines. Beam and conduit clamps are not acceptable, as they will not absorb the shock generated in the piping or tubing. Clamps should be spaced approximately 5 feet apart and installed within 6 inches of the pipe or tubing termination point.

Valve Testing

On any system, one or more valves will be closed while the system is operating. These include relief valves used with pressure-compensating pumps, air bleed valves and accumulator dump valves. The tank lines of these valves should be checked regularly with a temperature gun or infrared camera to verify that the valves are closed and no oil is being lost back to the reservoir.

Continuous flow out of a bleed valve may indicate worn piston seals.

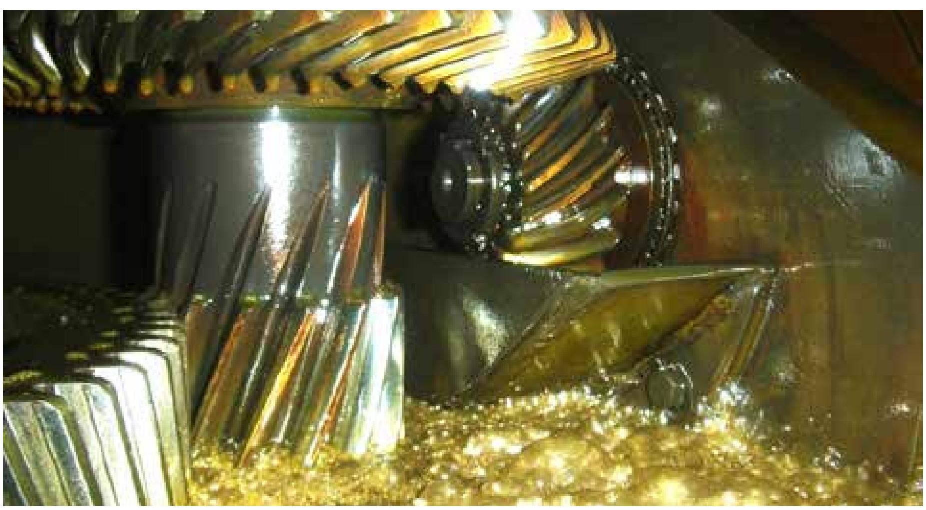
A reliability and preventive maintenance schedule should be developed for each of the hydraulic systems in your plant. By performing these tests, your systems will operate safer and at maximum efficiency while reducing unexpected downtime. ■

About the Author

Al Smiley is the president of GPM Hydraulic Consulting Inc., located in Monroe, Georgia. Since 1994, GPM has provided hydraulic training, consulting and reliability assessments to companies in the United States, Canada, the United Kingdom and South America. Contact Al at gpm@gpmhydraulic.com.

C M Sharma | VAS Tribology Solutions

You have abnormal foaming of oil in a gearbox



Lubricating oils are not completely free of air. Whether during operation or storage in barrels, oils are constantly in an exchange process with their air-containing environment. Even if the oil is free of air bubbles, it will have a proportion of dissolved air. This depends primarily on the gas solubility, but pressure and temperature also have an effect. Some mineral oils can have air content approaching 9 to 11 percent volume at atmospheric pressure and room temperature. As long as the air remains dissolved in the oil, this generally is not a problem. However, free air bubbles, which usually are caused by constantly immersing machine parts or through oil returning to the reservoir, can lead to serious disruptions in equipment operation, including impaired cooling effect, increased oxidation tendency, shortened oil life, reduced carrying capacity of the lubricant film, oil spills, decreased oil pump capacity, lack of lubrication, cavitation and micro dieseling. Air release cannot be improved by additives. However, the foaming behaviour of lubricating oils can be improved by anti-foam additives, which reduce the surface tension of the oil, i.e., by the well-proportioned addition of silicon - containing compounds or oil - soluble polyglycols.

Too many anti-foam additives can lead to a significant deterioration of the air-release capability. It is always a good practice to consult your lubricant supplier first for advice.

Symptoms

Foam is a collection of small bubbles of air that accumulate on or near the surface of the fluid. In severe cases, the foam can leak out of the machine through breathers, sight glasses and dipsticks.

Foam is an efficient thermal insulator, so the temperature of the oil can become difficult to control.

Foam is an object formed by trapping pockets of gas in a liquid or solid. A bath sponge and the head on a glass of beer are examples of foams. In most foams, the volume of gas is large, with thin films of liquid or solid separating the regions of gas.

Foam and Air Release

Oil returning to a reservoir has enough time to separate air in the form of air bubbles. The main influences on the speed at which these air bubbles separate from the oil and rise include the size of the bubbles, the oil's viscosity and the oil temperature. The amount of dispersing additives, the oil's density and any impurities also play a role. As air bubbles arrive at the surface, surface foam is formed. Therefore, foam consists of a series of air bubbles, which are each surrounded by a skin of oil. As a function of the oil's surface tension, this skin of oil can burst more or less rapidly. The time it takes for the ascended bubbles to burst and achieve complete separation from the oil is mostly dependent on the oil's viscosity and temperature, but the content of polar aging products, impurities and certain additives also have a bearing. The oil property that describes how fast these ascended bubbles burst is called the foaming behaviour.

Operational Causes of Foaming

The possible causes of foam formation in gearbox can be divided into two groups: transmission and lubricating oil. If lubricating oil mixes with other lubricants or contaminants such as dust or water, foaming can result along with oil aging, which leads to the formation of polar oil-aging products, an increase in viscosity or filtering out of anti-foam additives by bypass filters. In practice, you often see an overlap of several factors. While each factor on its own would not be a problem, a combination of these factors can lead to increased foaming. This makes it difficult to identify the actual causes.

Flender Foam Test

The measurement of foaming characteristics according to Flender is standardized in ISO/DIS 12152. Flender has developed special test and standardized. This test delivers much more reliable results and can improve the reliability of gear oils. The examples given demonstrate the application of these test procedures and offer an overview of foaming problems as well as their cause. The upper limit of more than a 15-percent increase in the oil volume one minute after stopping the instrument does not equate to an actual foaming limit for existing gearboxes. This limit is only valid for the test instrument and the standardized test procedure. It is based on the experiences of Siemens (Flender) in meeting the requirements of Flender gearboxes. Some filter manufacturers have even included the Flender foam test in their testing procedures to avoid problems with removed anti-foam agents.

Contact C M Sharma at
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THE RIGHT WAY to Lubricate WORM GEARS

Of all the different types of gear configurations, worm gear systems are considered some of the most problematic because they present unique lubrication challenges due to their distinct design. To overcome these challenges, you must understand not only the complexities of worm gears but also which qualities to take into account when choosing a worm gear lubricant.

Worm Gear Designs

A worm gear is a non-parallel, non-intersecting axis design consisting primarily of two gear elements: the worm, which is the driving gear in the shape of a spiral or screw, and the worm gear or worm wheel, which is the driven gear in the shape of a common spur gear.

Technically, the entire worm gear system should be called a worm drive or worm gearset to avoid confusion. The worm always drives the worm wheel. This design characteristic is due to the extreme helical angle, which is nearly 90 degrees. The worm drive resembles the design of the crossed helical gear configuration, except the gear teeth on the worm of a worm drive will circle around the circumference of the worm at least once. Since the worm may have as little as one tooth that spirals radially around the helix, the number of teeth on the worm is more appropriately identified by the number of starts or threads.

There are three categories of worm drive designs that describe the degree to which the gears mesh together: non-throated (non-enveloping), single-throated (single-enveloping) and double-throated (double-enveloping or globoidal).

Non-throated or non-enveloping is the most basic design in which the worm and worm wheel are both cylindrical in shape. This allows for simplistic manufacturing, but the limited contact zone of a single point on one or two gear teeth can become problematic.

In single-throated or single-enveloping designs, one of the gear elements (most commonly the worm wheel) has concave helical teeth for contour or envelopment of the gear teeth onto the worm. This enables the contacting zone to increase to a line.

Double-throated (double-enveloping) or globoidal designs not only have concave helical teeth on the worm wheel, but the worm is also shaped like an hourglass so the two gear elements wrap around each other during motion. This results in nearly eight times more

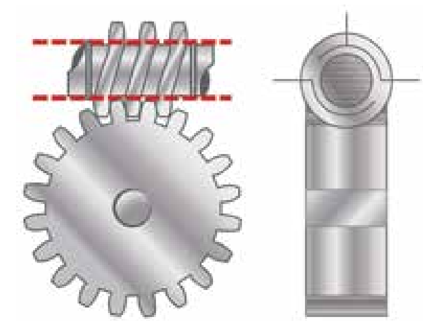

Figure 1. Non-throated (non-enveloping)

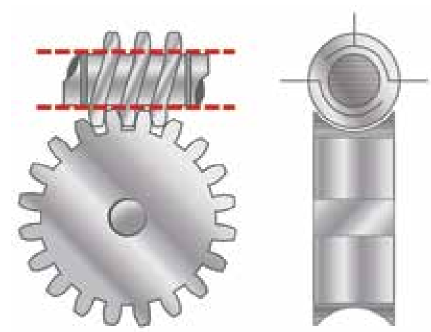

Figure 2. Single-throated (single-enveloping)

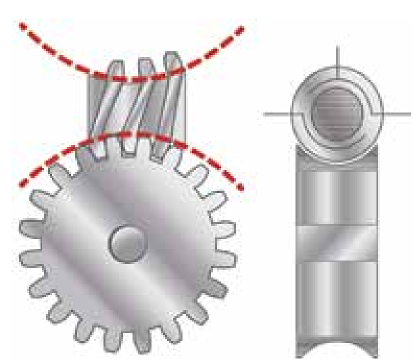

Figure 3. Double-throated (double-enveloping)

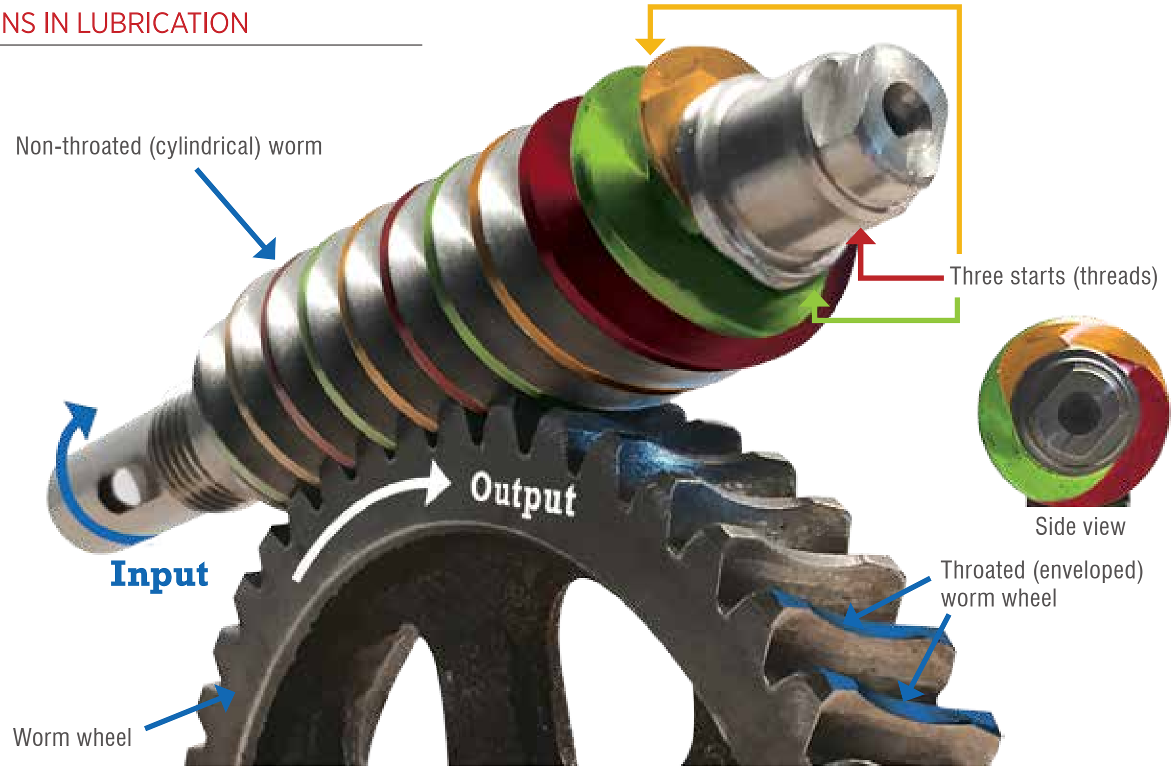

Figure 4. Single-throated (single-enveloping) worm drive

contact area (in the shape of a radial band) with three or more teeth in contact.

As the contact surface area increases, the torque capacity, load-holding ability (shock load resistance) and durability are improved. Enveloping gear designs also have a lower anticipated wear rate as a result of the load distribution. Worm drive manufacturers attempt to optimize this contact relationship between the two gear elements for improved reliability.

Other notable advantages of worm drives over potential gear system alternatives include:

- A worm drive can be designed with a gear ratio of more than 200-to-1, in comparison to that of a helical gear, which may be limited to 10-to-1 on a single reduction. The gear ratio for worm drives is the number of teeth on the worm wheel to the number of threads (or starts) on the worm.
- The high gear ratio and configuration of the two gear elements allow for a compact design, making the worm drive a great option for space-limited areas. In addition, the number of moving parts is reduced along with the opportunities for failure. However, this may be partially offset by a loss in efficiency from large increases in torque.
- Due to the extreme helical angle, switching the direction of power is nearly impossible. The worm wheel cannot easily be rotated independently to force movement on the worm. This self-locking ability eliminates the need for a backstop, which may be required in alternative gear systems.
- With the precise movement of worm drives, particularly in double-enveloping designs, backlash (play between gear teeth) can be greatly minimized. This is crucial in certain applications such as robotics.

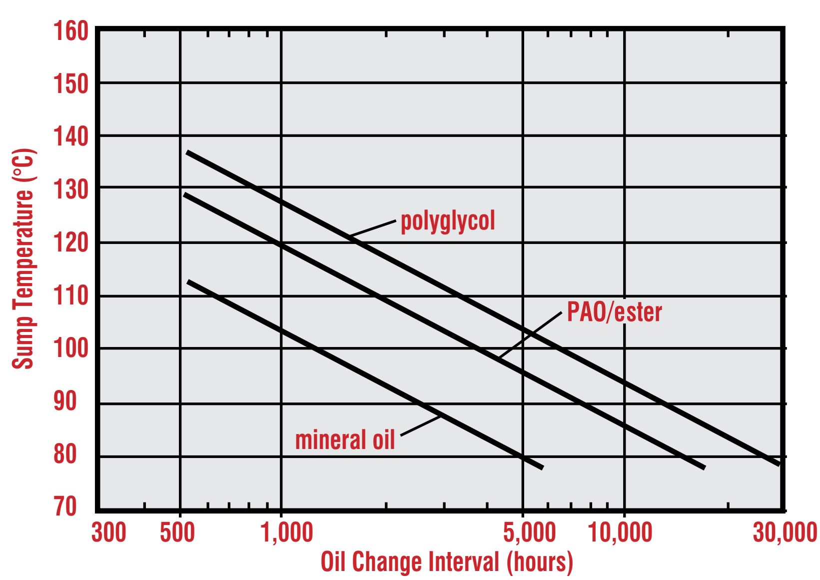

Figure 5. A comparison of lubricant life and oil change intervals for mineral oil, PAOs and PAGs over a range of oil sump temperatures

TYPES OF WORM DRIVE EFFECTS	ADVANTAGE OF A SYNTHETIC GEAR OIL OVER A MINERAL OIL
Reduction of total losses	30% or more
Improved efficiency	15% or more
Reduction of operating temperature	20˚C or more

Figure 6. Advantages of synthetic gear oil over mineral oil

- Low noise and vibration results from minimal moving components in worm drives in comparison to alternative gear designs.

Lubrication Challenges

Worm drive designs have one major drawback: the relative motion between the mating teeth of the two elements is almost entirely sliding. This poses a significant challenge because the lubricant is continually scraped aside. The sliding friction losses result in elevated temperatures and inadequate hydrodynamic pressure development. Consequently, wear debris generation can increase. In many cases, the higher temperatures will be the limiting factor on the worm drive before the loading limitations are reached. The load distribution of enveloping gear designs can lessen this problem, but the challenge still persists.

Also, because of the sliding nature of the worm drive, metals with a low coefficient of friction are generally used. The worm wheel typically contains yellow metals, while the worm is usually made of steel. This results in more favorable wear characteristics, better loading ability and less heat generation not found in other metal combinations. Yellow metals like bronze that are used on the worm wheel can present unique lubrication challenges when selecting a compatible additive package. With this metallurgical combination, it is also expected that the worm wheel act sacrificially in comparison to the worm due to the relative effort and costs in worm drive rebuilds.

Lubrication Solutions

Gearing designs and materials have been modernized through the years to achieve better load-carrying capability, higher torque conversions and improved longevity. Sophisticated testing platforms and computerized methods have provided a better understanding of common worm drive failure modes and offered clues for optimizing the solutions. Lubricants are no exception to these enhancements for worm drives. Generally speaking, a high-quality worm drive lubricant will have low friction, high oxidation resistance, good anti-wear protection and high viscosity index.

The Right Base Oil

While using lubricants formulated with mineral oil is quite common within worm drives, employing synthetic base

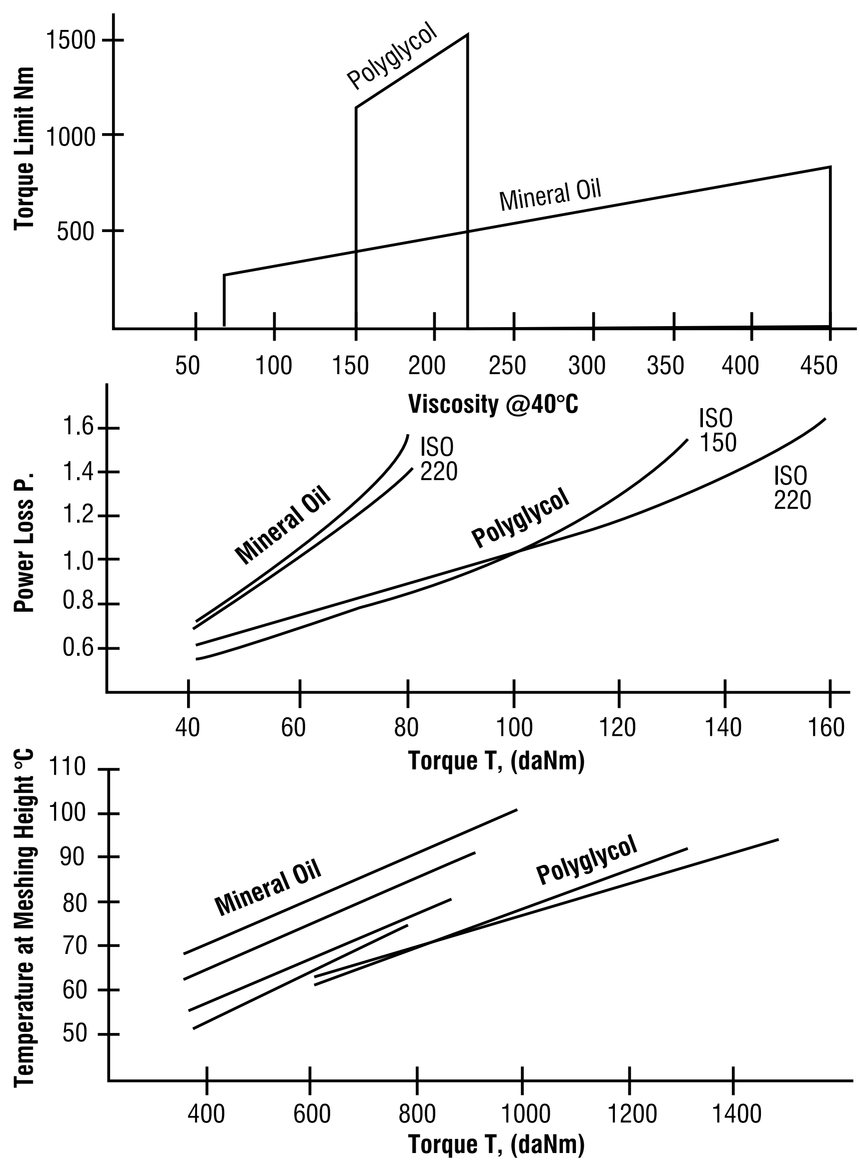

Figure 7. Polyalkylene glycol vs. mineral oil

oils generally results in improved gear efficiency and lower operating temperatures. Figure 5 illustrates lubricant life and oil change interval expectations for polyalphaolefins (PAOs), polyalkylene glycols (PAGs) and mineral oils over a range of oil sump temperatures. This is supported by the Arrhenius Rate Rule, which states that for every increase of 10 degrees C in the average oil temperature, the chemical reactions double.

The energy transmission efficiency of the gear system's input and output can be significantly influenced by the lubricant selected. Figure 6 specifies the improved efficiency when choosing a synthetic over a mineral oil, particularly PAGs, which have an inherently low coefficient of friction. PAGs are also known to reduce operating temperatures and total losses. Additional comparisons between mineral and PAG base oils are seen in Figure 7.

PAGs do have some drawbacks, most notably their higher costs. They also are not compatible with some seal materials, plastics and paint coatings, so always confirm compatibility when switching to PAGs.

The Right Additives

One of the most important jobs of a gear oil additive is to form a protective or sacrificial barrier between contacting surfaces when the conditions exceed that of the bulk oil's film strength. An additive package for a lubricant in a worm drive must be selected with care, since the yellow metals often contained within worm wheels can be adversely affected by corrosion from the activated sulfur within the extreme-pressure (EP) additive, particularly in the presence of heat. Nevertheless, advancements in additive formation with deactivated sulfur have helped to reduce or eliminate these corrosive attacks.

Worm drives can present a unique boundary lubrication challenge, with the focus more on friction reduction than on the effects of wear. In these applications, a specific type of mineral-based lubricant known as a compounded oil can be used. This lubricant is formulated with up to 10 percent fatty acid (natural oil) or acidless tallow as the compounding agent along with rust and oxidation inhibitors and other additives. This results in improved lubricity, reduced friction and decreased sliding wear.

EP oils are still commonly used in worm drive applications where they are formulated with yellow metal

PITCHLINE VELOCITY OF FINAL REDUCTION STAGE	ISO VISCOSITY GRADES		
	Ambient temperature (°C)		
	-40 to -10	-10 to 10	10 to 55
Less than 2.25 m/s	220	460	680
More than 2.25 m/s	220	460	460

NOTES: Worm gear applications involving temperatures outside the limits shown above or speeds exceeding 2,400 rpm or 10 m/s sliding velocity should be addressed by the manufacturer. In general, for higher speeds, a pressurized lubrication system is required along with adjustments in the recommended viscosity grade.
This table applies to lubricants with a viscosity index of 100 or less. For lubricants with a viscosity index greater than 100, wider temperature ranges may apply. Consult the lubricant supplier.

Figure 8. ISO viscosity grade guidelines for enclosed cylindrical worm gear drives

CENTER DISTANCE OF FINAL REDUCTION STAGE	WORM SPEED OF FINAL REDUCTION STAGE (RPM)	ISO VISCOSITY GRADES			
		Ambient temperature (°C)			
		-40 to -10	-10 to 10	10 to 35	35 to 55
Up to 305 mm	<300	460	680	1000	1500
	300-700	320	460	680	1000
	>700	220	320	460	680
More than 305 mm to 610 mm	<300	460	680	1000	1500
	300-500	320	460	680	1000
	>500	220	320	460	680
More than 610 mm	<300	460	680	1000	1500
	300-600	320	460	680	1000
	>600	220	320	460	680

NOTES: Worm gear applications involving temperatures outside the limits shown above or speeds exceeding 2,400 rpm or 10 m/s sliding velocity should be addressed by the manufacturer. In general, for higher speeds, a pressurized lubrication system is required along with adjustments in the recommended viscosity grade.
This table applies to lubricants with a viscosity index of 100 or less. For lubricants with a viscosity index greater than 100, wider temperature ranges may apply. Consult the lubricant supplier.

Figure 9. ISO viscosity grade guidelines for enclosed globoidal worm gear drives

Photos courtesy Agnee Transmissions

POSITION	Worm-under (worm on the bottom)	Worm-over (worm on the top)	Vertical (worm on the side)
OIL LEVEL	Wheel immersed at approximately one-third of its diameter	Wheel immersed to approximately the center of the meshing zone	Half the wheel immersed to at least worm height

Figure 10. The three most common worm drive positions (Ref: *The Lubrication Engineers Manual*)

compatibility. However, both compounded oils and EP gear oils have a working temperature limitation of approximately 80 degrees C before oxidation rates rapidly increase, resulting in acidic products that can attack cupric worm wheel materials.

The Right Viscosity

Aside from the ambient and operating temperature, the correct viscosity will depend on several variables of the final worm wheel, including the pitchline velocity, center distance and revolutions per minute. Figures 8 and 9 provide recommendations for the ISO viscosity grade selection on cylindrical and double-enveloped worm drives according to the American Gear Manufacturers Association (AGMA) 9005-E02 standard.

As these recommendations and the oil change interval chart show, temperature has a significant impact on effective lubrication. Not only are the lubricant and machine longevity negatively affected by higher temperatures, but worm drives in particular have trouble with temperature spikes. As a result, if higher temperatures are expected, more effective alternatives for base oils and additives should be selected. Synthetic oils such as PAOs and PAGs perform better than mineral oils due to their naturally higher resistance to thermal degradation. Nevertheless, an increase of 32 degrees C above the ambient temperature in single-throated worm drives (37 degrees C for double-throated worm drives) is not considered excessive for the operating conditions.

The Right Oil Level

As with most splash-lubricated gear systems, the oil level in a worm drive is essential to maintain accuracy. Depending on the position of the worm relative to the worm wheel, a small drop in oil level could be the difference between ideal lubrication and no lubrication. When monitoring the oil level in the three most common worm drive positions (Figure 10), adhere to the manufacturer's recommendations, which will often be in line with the standards for depth of oil immersion.

When the pitchline velocity of the worm elements exceeds 10 meters per second, particularly with double-enveloping worm drives, a force-feed lubrication system is recommended to spray the entire face of the worm.

The Right Visual Inspections

Besides monitoring the oil level, a sight glass should be regarded as a window into the oil's condition. This may include visual checks for unusual oil darkening (a sign of oxidation), visible sludge, solid particles and moisture. These inspections can be performed more efficiently when the sight glass is extended out from the gear housing so light can be passed through it, as in the sight glass shown on the left.

If possible, a bottom sediment and water bowl should also be used. This will help capture any solid particles or liquids that are heavier than the oil and provide a daily visual inspection point.

The Right Choice

The goal of any chosen lubricant should be to protect the worm drive from undesirable levels of friction, the dangerous effects of corrosion and inefficient operation. Assessing and achieving the optimum reference state for every style of worm drive in accordance with its operating and environmental conditions will come down to one thing: justifying the costs of improved lubrication practices to minimize the risk and potential consequences of failure. Fortunately, improving lubrication practices for worm drives should not be costly and may be as simple as confirming that the lubricant meets the minimum requirements while performing visual inspections and even oil analysis for effective condition monitoring. Just as worm drives are some of the most simplistic and beneficial gear designs, the lubrication practices that they require are equally unique and essential. ■

About the Author

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By Bryan Johnson, Palo Verde Nuclear Generating Station

How Light Affects Oil Analysis Results for Varnish Potential

As oil or oil additives degrade, they develop varnish and begin to accumulate this material within the oil. The amount of varnish carried by or within the oil will progressively increase as the oil continues its service. The oil's carrying capacity for varnish will also fluctuate based on temperature. As the oil becomes saturated, this material can settle from the oil and form harmful deposits. Fortunately, varnish can be extracted from oil and measured in a laboratory by its change in color.

The ASTM D7843 standard provides requirements for performing membrane patch colorimetry (MPC) testing. However, this test has been found to be biased by exposure to ultraviolet (UV) light. A recent experiment demonstrated that overhead lighting, such as fluorescent lights, can have a similar effect. Therefore, caution is needed to avoid contact with all but incidental light when handling oil samples that will require an MPC test.

Increases in MPC measurements of 50 to 100 percent have been demonstrated following several days of exposure to indoor lighting only. As such, seemingly benign sources like fluorescent overhead lighting can dramatically alter MPC varnish test data. For example, one oil sample increased from a measurement of 21 to 41 in a 16-day period due to exposure to fluorescent lighting.

Case Study

For a comparative study, a single oil sample drawn from a large turbine oil reservoir was processed for an MPC measurement. The sample was split and placed into light-blocking and translucent sample bottles at the time of sampling. All the bottles were made of high-density polyethylene (HDPE).

A series of tests was designed to determine the impact of time and temperature with the sample limited to light exposure within the laboratory. Duplicate oil samples were drawn on the same day by the same personnel. One sample was placed into the standard semi-translucent sample bottle. The second sample was drawn into a light-blocking brown bottle.

Caution is needed to avoid contact with all but incidental light when handling oil samples that will require an MPC test.

OIL SAMPLES	TRANSLUCENT CONTAINER MPC	LIGHT-BLOCKING CONTAINER MPC
As found, after 16 days (pre-heating)	39	26
Heated for 24 Hours at 60°C and Stored in a Dark Location		
3 days after heating	38	22
7 days after heating	40	24
14 days after heating	41	26
Reheated Samples		
7 days after second heating	40	27

MPC test data and test conditions

When the samples arrived at the laboratory for testing, a 90-milliliter subsample was immediately removed from the translucent container and placed directly into a dark drawer to match the standard practice. The sample was not reheated prior to storage. The 90-milliliter subsample was retained in the drawer for seven days from its date of sampling and then tested. An MPC of 21 was reported.

Both the light-blocking and translucent oil sample containers were staged on the laboratory counter surface for a 16-day period prior to additional MPC testing. In this amount of time, it would be expected that varnish would settle out of the oil. MPC measurements were made for both samples prior to heating to determine their as-found varnish levels. The translucent sample experienced a substantial increase from its initial 21 MPC measurements to a new level of 39. The light-blocking bottle increased its varnish load to an MPC of 26.

Both samples were then heated, as specified by ASTM D7843, to return the varnish bodies into the oil and then retested after allowing storage periods of three, seven and 14 days from the reheating. The sample containers were stored in a dark location between each test to avoid additional stress to the oil from any light source.

The translucent sample was found to have an MPC of 38 at three days, 40 at seven days and 41 at 14 days. The sample from the light-blocking container had a test measurement similar to the original 90-milliliter control sample with a reported MPC of 22 after three days. It rose to 24 after seven days and continued to increase to 26 after 14 days from the time of heating.

ASTM's Response

The research presented in this article was reviewed at a recent meeting of the ASTM Committee D02.C0.01 Turbine Oil Monitoring, Problems and Systems. We thank Bryan Johnson for bringing this matter to our attention. This is an example of a fluid user presenting research that helps to improve the value of our standards. With efforts like this, we make our standards better for all end users.

Sections 8.1 and 8.2 of D7843 discuss the requirement of protecting the sample from UV light, which we know can cause precision errors. However, these sections do not discuss specifically the potential harmful issues associated with fluorescent light. We already have an open work group item within our committee directed toward improvements of ASTM D7843 and have now added this research for potential modifications in the next standard revision.

Modifications of ASTM standards are not made lightly. They require full ASTM D02 ballot approval. Our objective is to recommend improved verbiage within the standard to reflect this user's input and its impact on precision so that future users can gain from this experience.

As you use ASTM standards in your business, keep in mind that we are always looking to improve the precision and value of our standards. Become involved and be a part of this improvement effort! – Dave Wooton, D02.C0.01 Committee Chairman

Both the light-blocking and translucent oil sample containers were then reheated a second time and stored in a dark location for an additional seven days. Retesting the sample from the translucent container produced an MPC of 40, while the sample from the light-blocking container was measured at 27.

Conclusions

The following conclusions were drawn from this experiment. The comparison of test data from the translucent and light-blocking sample containers supports observations that light exposure can significantly impact MPC test results. In this case, the light exposure from the lab's fluorescent lighting permanently doubled the test measurement within approximately two weeks.

Allowing the sample to remain at laboratory temperatures for a progressively longer time period resulted in moderate increases in test data. The variation in MPC test measurements for the light-blocking sample between a three- and seven-day period was less than 10 percent (22 to 24). Either time interval could be expected to produce acceptable trend data provided a single interval is used consistently. The results of the second reheating test also showed an increase for the light-blocking sample. This suggests an oil sample should be tested for MPC as soon as practical following its removal.

While light exposure can be managed by creating a subsample of the original sample taken in the field, which can then be separated and placed into a dark storage location, this alternative still affords the opportunity for the sample to be inadvertently left in a location with light exposure prior to being turned over to the lab for testing. In addition, the sample container may be exposed to laboratory light as it is processed, handled and tested. To avoid the possibility of poor handling practices for samples requiring an MPC varnish test, it is recommended that light-blocking sample bottles be used.

Use a Camera for Better Oil Analysis

Put your cellphone camera to good use by taking a photograph of an oil sample (if using a transparent sample bottle) and storing the image in a trending software for comparative purposes. Record a new oil sample and use this as a baseline. Set the bottle against a white background, like a sheet of paper, to maintain a consistent color comparison.

You can also use your camera in other ways, such as to record images of the machine and sampling point as a means of identifying them in the software or to record abnormalities such as excessive leakages for easy location by mechanics. Pictures are immediate and speak volumes, so use them to good effect in reports and trending software.

Advice for Replacing Brake Fluid

Brake fluid is highly hygroscopic, which means it absorbs moisture from the atmosphere. Apart from the obvious corrosion potential this presents to the master and slave cylinders, it also degrades the fluid's high-temperature performance. This results in the fluid boiling at a lower temperature, leading to the loss of fluid power when pressing the brake pedal. Follow the manufacturer's recommendations and change the fluid regularly. Synthetic silicon-based brake fluid is more expensive but does not need to be replaced as often. As custom and classic car owners know, it also does not damage the paint work.

How to Identify Suction Line Leaks

Suction line leaks can cause air entrainment and lead to problems such as excessive aeration, air lock, pump cavitation, poor lubrication and premature oil degradation. However, a pinhole-sized suction line leak can be hard to find. Using a small amount of shaving foam sprayed over the suspected leak area can indicate the source of the problem, as the foam will be drawn into the line. This method should not be used for large leaks, and care should be taken to not use too much soap, as this could contaminate the lube and result in foaming, aeration problems and poor demulsibility.

Tips for Lifting and Carrying Oil Drums

Always ensure the correct lifting and carrying equipment is available. Avoid lowering oil drums onto any small, sharp objects. These objects can pierce an oil drum and cause leakage, which if unnoticed, could pose a safety risk to the person moving the drum as well as other colleagues.

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

Particle Contamination & MEASUREMENT

Particle contamination can be described as any dirt (silica), metal, soot or soft insoluble material that is not designed to be present, but which gains access to the lubrication system. It has the potential to damage the lubricant and the component's lubricating surfaces.

There are several ways, where the contamination gets entry in to the lubrication system, mainly transportation, storage, handling and machine itself. Particles begin to cause different types of wear and drastically affect the additive depletion rate. Wear can occur on the lubricating surface through mechanical wear, chemical wear or surface fatigue.

Mechanical wear happens through a variety of different mechanisms. Adhesive mechanical wear, also known

as galling, scuffing or seizing, Abrasion, erosion, chemical wear, surface fatigue etc. takes place in different types of applications like heavily loaded, sliding-contact, rolling element bearing, gears, hydraulic systems, cylinders etc.

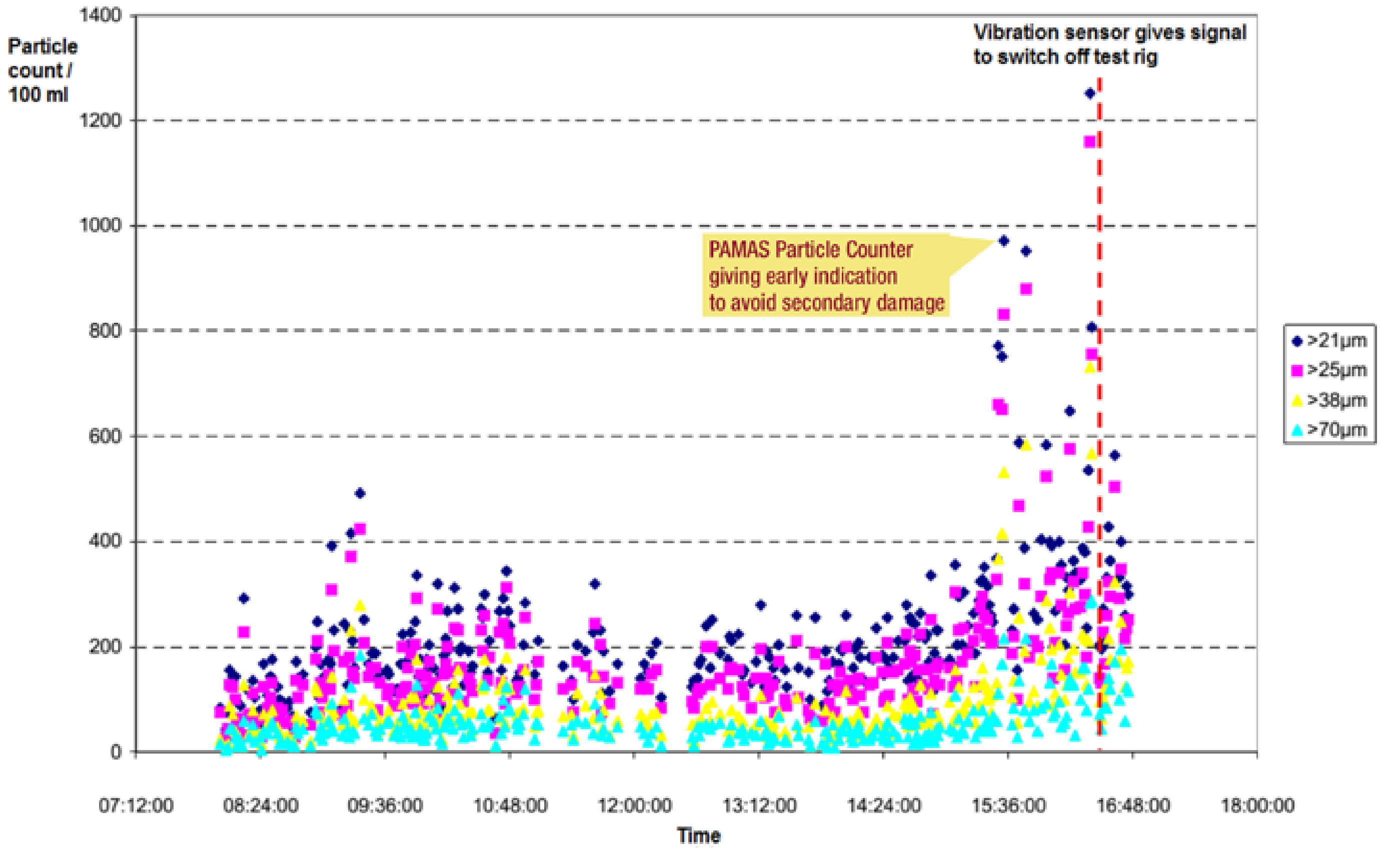
Contamination is the cause of approximately 90% of all hydraulic system failures. If the systems are maintained at the desired cleanliness level, which will provide you high efficiency, longer equipment life, more runtime.

How to plan an Action?

Data availability & trending is the base of every action plan. If we have a reliable meaningful data, then only we can take an action & get the desired results. Data will give us direction, what & where we need to take the action. Action without data is meaningless & waste of resources.

Reliable/Meaningful Data?

There are many different type of analysis instruments available in the market to check the particle contamination, but are they really giving you a meaningful or correct data? Many industries using cheap LED particle monitors, because their customers/authorities have asked them to have particle counters. These monitors are not fulfilling any requirements of ISO1171 & ISO4402, which is primary requirement of measurement. They are not calibrated



Particle Counter vs Vibration Sensor Analysis

& data authenticity is zero. To find out the particle contamination level, we need an instrument of high accuracy, high reliability, repeatability & traceability.

WHY PAMAS?

Only a reliable instrument can provide you reliable data with accuracy. PAMAS GmbH particle counters are well-known for its quality & performance. A volumetric sensor design gives you the power to analyze 100% of the sample taken by instrument. Sensor which can handle particle concentration of 24000/ ml & a viscosity range up to 1000cst @40 degree Celsius Two independent separate Calibrations as per ISO 4402 & ISO11171 standards. Only a meaningful data can lead you towards a successful & effective lubricating management system. Data authenticity is the base for planned action.

Avoid secondary damage by using PAMAS reliable particle counter, which will give you early indication of problem by providing you correct data for your lubrication condition.

Benefits of the only particle counter system with both ISO4402 (ACFTD) & ISO11171 (ISO MTD) calibration.

1. **Reduce Breakdown**
2. **Reduce Maintenance Cost**
3. **Reduce Oil Consumption**
4. **Increase Machine Life**
5. **Increase Efficiency**

Pioneer in the field of liquid application, produces the particle counter for every liquid applications like Oils, Lubricants, Fuels, Water, Water Glycol, Hydraulic Oils, Pharmaceutical, Chemicals and many more.

Loren Green | Noria Corporation

ADVANTAGES of Contracting Out Your LUBRICATION Program

Across industry there has been a move toward predictive and proactive maintenance, but unfortunately a large number of organizations are still operating in the reactive maintenance mode. This can be a difficult cycle to break due to the efforts required just to keep equipment running. Frequently, repairs only involve getting machines back up and not actually fixing them.

Many maintenance departments are also woefully understaffed. Even teams with sufficient personnel often spend so much time "fighting fires" to keep the plant operating that little time is left for predictive or proactive maintenance. There simply are not enough hours in the day and not enough maintenance mechanics to repair the equipment properly in many organizations. This creates considerable demand on resources in the form of parts, labor and time. In addition, the cost of a breakdown can be significant, with the repair of the breakdown only a small portion of the breakdown's total cost.

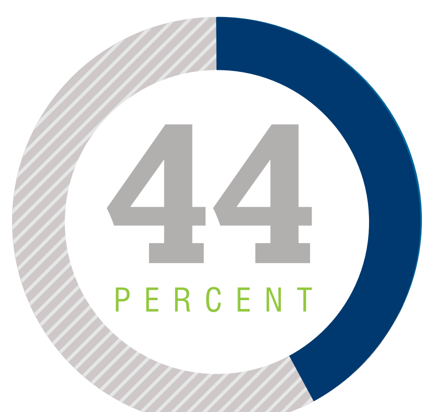
Studies have shown that most organizations spend only 5 percent of their maintenance budget on lubricants and lubrication, yet approximately 70 percent of equipment failures are lubrication related. This would include applying the wrong lubricant, relubricating too often or not often enough, using too much or too little lubricant, and not controlling contamination adequately. In the end, your maintenance dollars will be spent one way or another. It is just a matter of when and how much. If you skimp on lubricants, breathers, filters, etc., you will continue to spend vast amounts of money on equipment downtime and repairs.

Now consider the cost savings an effective lubrication program can provide in the form of increased equipment reliability, reduced lubricant consumption and fewer repair parts. Lower overtime costs could also pay for the program's implementation and management. Doesn't this sound like something that would be of interest to your plant manager?

Lubrication: A Skilled Trade

It is important to realize that proper lubrication is a skilled trade. Lube technicians must be trained how to determine which lubricant is best for each application. They should also know how to calculate the correct relubrication quantity and frequency. In order to learn these skills, technicians must be trained and certified. Just like every other skilled trade, lubrication requires a training and certification component.

With the average age of skilled workers approaching 60, more and more of these individuals will be retiring in the next several years. Sadly, few younger



of MachineryLubrication.com visitors say their plant outsources lubrication or maintenance tasks to contract-based laborers workers are entering into the skilled trades, which will leave a huge deficit of trained workers.

If you do not have immediate access to skilled, trained and certified lubrication technicians, it may be time to look into contracting out this function. A good contractor not only can provide trained and certified lube techs but can also help you develop procedures for your lubrication-related tasks as well as implement, maintain and manage your lubrication program. Granted, you will spend more than 5 percent of your maintenance budget, but in return you will lower your equipment's breakdown frequency and the costs associated with repair parts, overtime, downtime, etc.

Contractors should have the training and requisite skills to survey your facility and make immediate recommendations for equipment modifications, lubricant selections and other necessary changes. They should also be able to properly install the modifications, implement the procedures and lube routes, and monitor their completion.

In short, a contractor is equipped to walk into your facility and, in a very brief period of time, make significant improvements to your lubrication program that will be reflected on the bottom line. ■

PROGRAM FEATURE/NEED	PERFORMED BY IN-HOUSE TECHNICIANS	PERFORMED BY CONTRACTOR PERSONNEL
Lubricant Optimization		X
Lubrication PM Optimization		X
Lubrication Program Survey		X
Equipment Modification Recommendations		X
Equipment Modification Installation	X	X
Lubrication Program Management	X	X
Lubrication Inspections	X	X
Lubrication Activities	X	X
Lubrication Certifications	X	X
Lubrication Training		X

About the Author

Loren Green is a technical consultant with Noria Corporation, focusing on machinery lubrication and maintenance in support of Noria's Lubrication Program Development (LPD). He is a mechanical engineer who holds a Machine Lubrication Technician (MLT) Level I certification and a Machine Lubricant Analyst (MLA) Level III certification through the International Council for Machinery Lubrication (ICML). Contact Loren at lgreen@noria.com to find out how Noria can help you improve your lubrication program.

"Most organizations spend only 5 percent of their maintenance budget on lubricants and lubrication, yet approximately 70 percent of equipment failures are lubrication related."

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. Kinematic viscosity is commonly:

A) Measured at 40 degrees C

B) Measured at 100 degrees C

C) Determined using a glass capillary tube and gravity

D) Stated in centistokes at 40 degrees C

E) All of the above

2. A Beta(3)=200 filter:

A) Only removes 3-micron particles

B) Only removes particles less than 3 microns

C) Only removes particles greater than 3 microns

D) Removes some particles less than 3 microns

E) Removes particles between 3 and 200 microns

3. Oxidation inhibitors:

A) Help to prevent the formation of acids

B) Help to prevent viscosity increase

C) Are sacrificial and get used up

D) Answers A and B

E) Answers A, B and C

ANSWERS

1. E

Kinematic viscosity is measured in the lab using a glass capillary tube and gravity at both 40 and 100 degrees C. It is also stated in centistokes at 40 degrees C, so the correct answer is "E."

2. D

The number of particles greater than 3 microns upstream divided by the number of particles greater than 3 microns downstream equals 200. However, this doesn't mean all particles less than 3 microns will pass through the filter.

3. E

An oxidation reaction results from the sequential addition of oxygen to the base oil molecules to form different chemical species including acids. The presence of oxidation inhibitors helps protect the base oil from oxidation, thus preventing the formation of organic acids. Oxidation byproducts normally combine to form larger molecular species, which leads to polymerization. Because viscosity is directly related to the size of the molecules, any degree of polymerization results in an increase in viscosity. Oxidation inhibitors are sacrificial like many other additives, which requires close monitoring. Thus, the correct answer is "E."

FROM THE READERS

Comments and feedback from some of our valued readers from different industries.

"I am a regular reader of "Machinery Lubrication India" since the year 2013-14. I sincerely appreciate the content supplied in each edition in terms of quality, practicality & relevance to the plant machineries. On completion of bright & successful 07 years, I congratulate the team working behind the "Machinery Lubrication India" and wish to establish great benchmarks in the future."

Girish Chandra Yadav
Manager- Reliability & Planning
Yara Fertilisers India Pvt Ltd., India

"I love each article of this magazine. I appreciate your methodology of explaining each topics and subjects, step by step, so that it can be implement able practically in the industry. I am using opportunity of sharing the relevant articles to my team and used to ask them to refer this magazine regularly found that most of the articles are interesting perspective which are very much pertinent to our profession and sometimes, we practice the same in addressing the prevailing issues. The case studies shared in the magazine are an excellent examples wherein, one can have vital takeaways."
Please continue the good efforts, all the best team.

Jeetendra Kumar Jain
Assistant Vice President - Operations
Nuvoco Vistas Corp Ltd., India

"Machine Lubrication India has always been the go-to publication for anything concerned with lubricants, both for users as well as marketers. Heartening to see that it presents a very analytical view of the Indian lubricants landscape. Congratulations to the team for completing 7 splendid years and wishing many more to come."

Imtiaz Ahmed
General Manager-Marketing Deployment Commercial Marketing
ExxonMobil Lubricants Private Limited, India

"Machinery Lubrication India magazine, congratulations on reaching your 7 year anniversary, it is a well-researched, well written and insightful publication, with many practical and useful articles for lubrication professionals to use to improve and develop the lubrication practises now and in the future."

Michael Hooper
Noria Corporation, New Zealand

"It gives me great pleasure in extending our heartiest congratulations to the team of Machinery Lubrication India (MLI) on its 7 long years successful journey. I believe MLI, the first of its kind, have set a new standard of excellence by offering a comprehensive and perspective overview on lubricants, lubrication and reliability. MLI helps me to get insight into lubricants industry by delivering information, reporting and making comment in a meaningful and relevant way. We greatly appreciate and value your hard work and effort to provide us a unique publication." Happy anniversary and sincerest best wishes for many further successes !

Mosaddek Hossain [MLA-II, MLT-I, ICML, USA]
CEO, MEDCO Country Manager
REVZOL Lubricants Solution, Bangladesh

"Kudos to the Team at Machinery Lubrication on publishing such an informative magazine on a subject not covered by anyone else. Hearty Congratulations on your 7th Anniversary and Our best wishes for many more years of publications."

Ashish Gupta
Sr. Vice President
Emami Paper Mills Ltd., India

"We compliment and congratulate Machinery Lubrication India on its 7th Anniversary which is India's only publication on lubricants, lubrication & reliability.The magazine is much beyond few words of appreciation. It's one of the best technical literature full of knowledge; theoretical and practical, valuable for Indian industries of all kinds, filling knowledge gaps, affecting very seriously , reliability of plant equipment. It has potential to save the industries if articles are read & implemented seriously. Magazine, which is free of cost, but invaluable by its content is a great service given to our industry. Our wholehearted appreciation and best wishes to MLI for its future journey."

Rajiv Deshmukh
Vice President (Engineering)
Ultratech Cement Ltd., India

"The "Machinery Lubrication Magazine" editions have been consistent in bringing better informed and more conscious facts about lubrication technology, through technical papers by experts across the industry. Referring to an article by Matthew Adams (March-April 2019 issue), to control three types of contaminants, was an eye opener. Have practically experienced the functional transition of our bearing operation, by following the mentioned easy techniques. Certainly, appreciate this modular concept which is much required in today's competitive scenario, where in equipment has to be pushed to the limits to perform. Looking forward for more of such compatible solutions from Machinery Lubrication.

Kaushal Kumar Mishra
Vice President - Group Head - Maintenance
Ambuja Cement, India

"MLI has been more successful by providing case studies, tutorials, practical tips, news, book reviews, and interactive content with examples. Always the content are up-to-date with the current naval trends in the world. More useful for trouble shooting in Lubrication related issues too. Proactive Best Practices and Maintenance strategies are most relevant in our Lubrication Management Journey. All the best for your 7th Anniversary!!

Ishanth Sameera
RCM Senior Manager – Central Engineering Division
Camso Loadstar, Sri Lanka

UPCOMING EVENTS

☑ Mark Your Calendar

NOVEMBER 2019 04 - 06
Noria 2019 Machinery Lubrication Conference & Exhibition
Houston, Texas, USA

NOVEMBER 2019 05 - 07
ICIS African Base Oils & Lubricants Conference
Cape Town, South Africa

NOVEMBER 2019 06 - 07
ELGI STLE Tribology Exchange Workshop
Amsterdam, The Netherlands

NOVEMBER 2019 12 - 13
ICIS & ELGI Asian Industrial Lubricants Conference
Singapore

NOVEMBER 2019 20 - 21
ACI Annual European Base Oils and Lubricants Summit
Rotterdam, The Netherlands

DECEMBER 2019 04 - 06
ICIS Pan American Base Oils & Lubricants Conference
Jersey City, New Jersey, USA

DECEMBER 2019 08 - 12
ASTM D2 Commitee on Petroleum Products, Liquid Fuels & Lubricants
New Orleans, Louisiana, USA

JINDAL STEEL & POWER

Lubrication INSTITUTE
www.lubrication-institute.com

Practical Industrial Lubrication Orientation Training **(PILOT)** , a specially designed accessory and activity-based training for Lube Techs and Plant Engineers was conducted on 5th and 6th September 2019 at Jindal Steel and Power Limited (JSPL), Angul, Odisha. PILOT is a skill-based lubrication training program specially designed for lube technicians, operators and shop floor associates. The objective of this program is to upgrade the skill of technicians who actually perform the lubrication and inspection tasks.

This training is a combination of classroom as well as onsite practical training (activity and accessory based). The main focus of this training is to illustrate how to perform various lubrication related tasks effectively, efficiently and safely. For more details on this training program and other trainings, visit - http://lubrication-institute.com/

NCOC
NORTH CASPIAN OPERATING COMPANY

Three-day training on Oil Analysis Fundamentals was conducted for North Caspian Operating Company (NCOC) at their laboratory in Kazakhstan from 9-11th Sept 2019. This course was specially designed for the chemists working in their Oil Analysis Laboratory and covered various methods of Oil Analysis and how to interpret the oil analysis reports.

TOTAL

Lubrication™ INSTITUTE www.lubrication-institute.com

Lubrication Institute in association with Noria Corporation, USA successfully completed a 3-day training specially designed training for TOTAL OIL from 23 -25th Sept 2019 at Mumbai. The training contained details of Machinery Lubrication & Oil Analysis (basic & advanced). Amongst many other topics, the training included oil sampling, lubricant health monitoring, contamination measurement control and wear debris monitoring. Franck Eydoux, Managing Director, TOTAL Marketing & Services Research Centre handed over the certificates to the participants.

BASE OIL REPORT

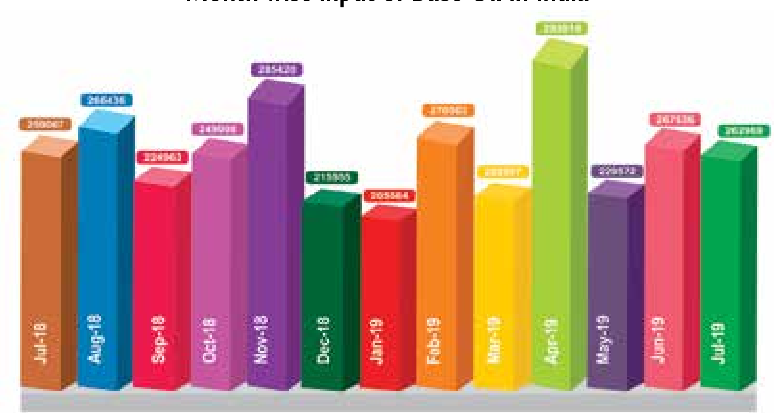
India witnessed the highest increase in crude oil imports in the first four months (April-July) of the current fiscal year 2019-20 (FY20) from the US. India's crude oil imports from the US tripled to 3.60 million tonne (MT) in the period from 1.15 MT recorded in the corresponding period a year ago. A bulk of crude oil shipments from the US was received by Reliance Industries port located in Jamnagar's special economic zone (SEZ). India's crude oil imports from Iraq increased 3 per cent to 16.05 MT in April-July of FY20. Nayara Energy-owned Vadinar Port was the second-largest receiver of Iraqi crude oil shipments in first four months of FY20, handling close to 3.08 MT of crude oil during the period. However, the port's shipments of Iraqi crude declined 16.30 per cent during first four months of the current financial year, as compared to the corresponding period a year ago. India's crude oil imports from Saudi Arabia increased 5.61 per cent to 13.34 MT in first four months of FY20.

The Indian domestic market Korean origin Group II plus N-60–70/150/500 price at the current level is 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. 44.75 – 44.90/45.30 – 45.45/50.75 – 50.90 per liter in bulk plus 18% GST as applicable. Discounts being offered for sizeable quantity.

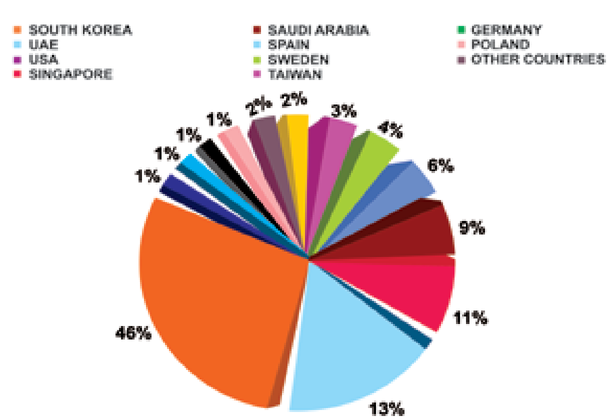
While in the month of July 2019, India imported 262,969 MT of Base Oil, India imported the huge quantum in small shipments on different ports like 151504 MT (58%) into Mumbai, 34385 MT (13%) into Chennai, 26742 MT (10%) into JNPT, 15012 MT (6%) into Kolkata, 11266 MT (4%) into Hazira, 8567 MT (3%) into Pipavav, 8222 MT (3%) into Kandla, 5017 MT (2%) into Mundra, 1676 MT (1%) into Ennore and 576 MT into Other Ports.

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

Month wise input of Base Oil in India



Origin wise Base Oil input to India, Country and %- July 2019



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

Month	Group I - SN 150 Iran Origin Base Oil CFR India Prices	Napthenic Base Oil HYGOLD L 2000 US Origin CFR India Prices	N- 70 South Korea Origin Base Oil CFR India Prices	Rubber Process Oil (Aromatic Extract) (Drums) Iran Origin CFR India Prices
July 2019	USD 595 – 605 PMT	USD 695 – 705 PMT	USD 640 - 650 PMT	USD 375 – 380 PMT
August 2019	USD 580 – 590 PMT	USD 680 – 690 PMT	USD 625 - 635 PMT	USD 360 - 365 PMT
September 2019	USD 570 – 580 PMT	USD 670 - 680 PMT	USD 615 - 625 PMT	USD 350 - 355 PMT
	Since July 2019, prices have decrease by USD 25 PMT (4%) in September 2019.	Since July 2019, prices have fall down by USD 25 PMT (4%) in September 2019.	Since July 2019, prices have decrease by USD 25 PMT (4%) in September 2019.	Since July 2019, prices have dipped down by USD 25 PMT (7%) in September 2019.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