March-April 2021

Machinery Lubrication

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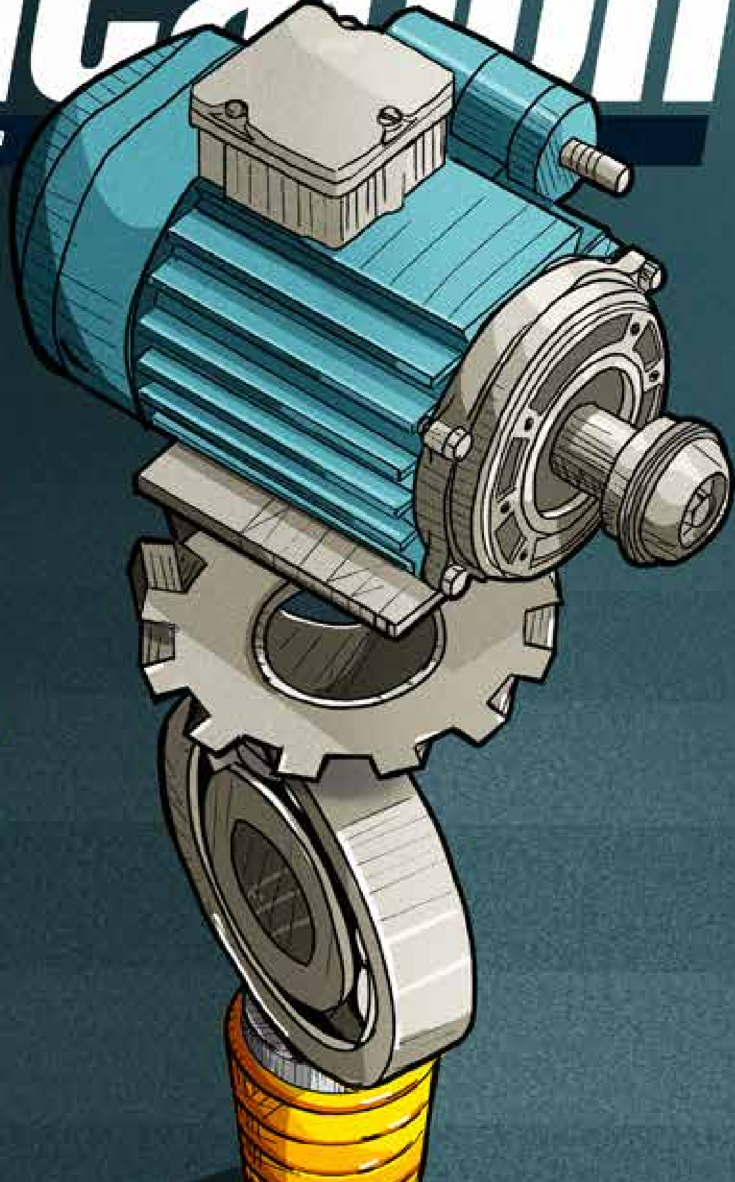

RISK MANAGEMENT
FOR LUBRICATED MACHINES

ALSO INSIDE
- Distinguishing Regulators and Reducing Valves
- Circulating Oil Systems: What You Should Know

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ADVANCE MACHINERY LUBRICATION (MLT II)	21-24th JUNE	–	–
ADVANCE OIL ANALYSIS (MLA III)	20-23rd DEC.	–	–
MACHINERY LUBRICATION ENGINEER (MLE)	25-30th OCT.	–	–

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TABLE OF CONTENTS

Machinery Lubrication INDIA

EDITORIAL FEATURES

Publisher's Note

Across all industries, safety should be the most significant consideration in getting work accomplished. Regardless of how urgent maintenance or a repair might be, it must be completed in a safe manner.

While many people do not think of the safety implications of lubrication, they certainly exist. Routine lubrication such as top-ups and greasing normally occur around moving equipment. When you are near machines that rotate or move, you must exercise caution to avoid getting yourself or a tool caught in the nip points. You could easily be hurt by coming into contact with a fast-rotating shaft or having a finger trapped between two meshing surfaces. Most equipment will have guards in place to ensure people stay out of these potentially dangerous areas.

As you walk around equipment, you may notice an occasional oil leak on the floor. Not only are they costly in terms of make-up fluid and contaminant ingress, but they also pose a danger for slips, trips and falls. Stage spill-containment equipment and material throughout your plant so it will be easily accessible. All staff should also be trained on how to use these materials and on the company's policy for disposing of lubricant waste.

Normal oil sample extraction is performed with dedicated sample valves. The valve is a safety device to help reduce the risks associated with collecting a sample from a pressurized system. In equipment such as hydraulics where the fluid pressure can be very high, it is best to use a pressure-reducing sample valve. This will lower the pressure of the oil stream so it will be safer and easier to capture in a sample bottle.

There are also risks related to greases at high pressures. In some cases, the connection between the fitting and the grease gun coupler is the easiest place for the grease to go.

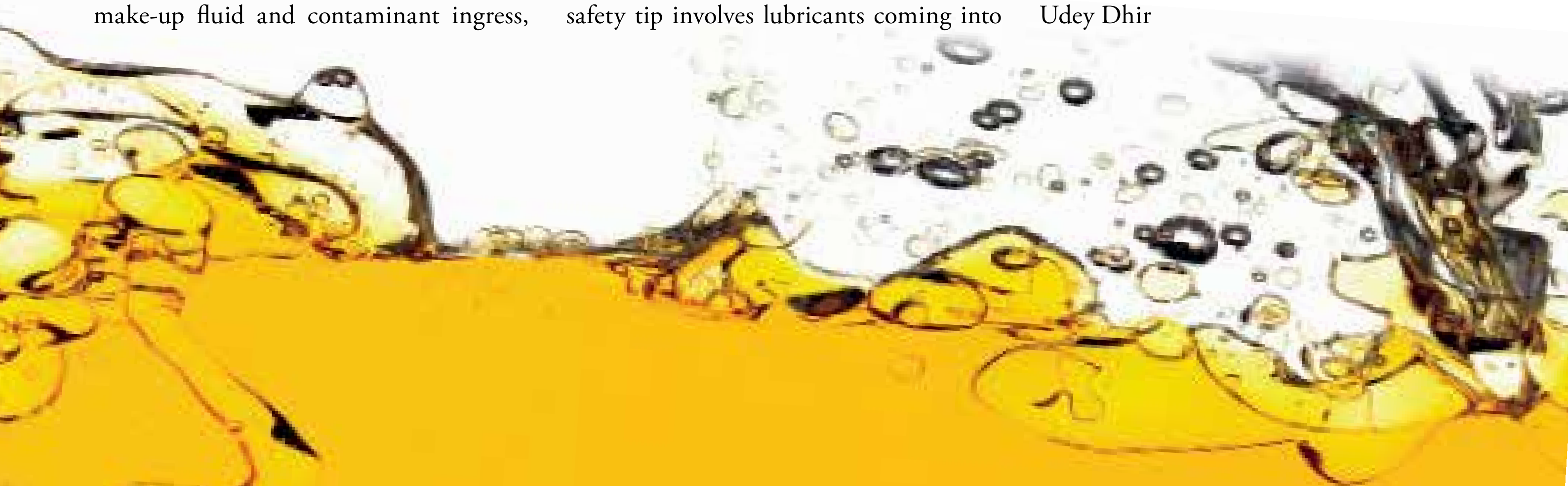
Lubrication is a hands-on job, so the last safety tip involves lubricants coming into contact with skin. You must minimize this contact by using gloves or barrier creams and washing off lubricants with soap and water. Although there isn't a great risk of contact with lubricants, certain synthetics and additives present some health concerns. Lube safety is largely common sense, but always check the lubricant's safety data sheets to determine how it should be handled.

We would like to thank our readers for the great response to our previous edition's cover story – "Monitoring Lubricants in the Digital Era" and other articles.

Our current issue's cover story is "Risk Management for Lubricated Machines" which will help our readers to know about the key proactive and preventative actions to minimize or eliminate risks.

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

Warm regards,
Udey Dhir



The Most Important Lubrication Inspection

Abnormal Changes in Oil Level

"Whether oil goes up or down, any sudden change in the oil level requires troubleshooting."

A sudden change in oil level, either up or down, is a telegraphed alert that something is wrong. And, this "something" could potentially be serious. Deferring maintenance or ignoring this alert could lead to a costly repair and longer downtime in the future. The frequent examination of quality oil level sight glasses by trained inspectors is a sound condition monitoring practice. Perhaps the most important of all lubrication-related inspections.

Whether oil goes up or down, any sudden change in the oil level requires troubleshooting in search of the cause and corrective action. Just adding more oil or removing excessive oil is an activity of treating the symptom, not the cause. True, some oil level changes are rather common and quickly understood. For instance, if oil goes sharply down, you might have a conspicuous leak (internal or external) that can be easily found and plugged.

Internal leakage occurs when a fluid has gone from one compartment to another. Leakage may be associated with seal failure or perhaps the wrong oil in use. Low viscosity oils leak faster than high viscosity oils. An abrupt chemical change in a lubricant can affects its interfacial tension which can increase the rate of leakage.

If the oil level goes up, this may be due to the introduction of new fluid. For example, perhaps someone added too much oil, or another fluid like a coolant or even fuel has entered the system, which has raised the oil level.

What do Changes in Oil Level Mean?

Oil Too High:

When oil levels rise above the acceptable range usually something new has been added, i.e., a new fluid. But there are other options too.

- **Too much makeup fluid.** Adding makeup fluid without carefully watching sight glasses can cause over-lubrication.

- **Oil drain back.** If fluid is topped off while the machine is running, the oil level can climb when it stops and oil drains back from gears, bearings, oil galleries and distant zones or oil ways.
- **Aeration and foam.** Such conditions can double or triple the apparent oil level.
- **Internal leakage.** Various sources of internal leakage can cause other nearby fluids to invade the sump. These include coolant, washdown fluids, fuel, heat transfer fluid, hydraulic fluid, grease and process fluids. Oil analysis can identify these fluids.

Oil Too Low:

This is usually caused by leakage, but there are other reasons.

- **Out-leakage.** This is an alert to examine the machine for any visual sign of oil leakage to external surfaces (oil exiting the machine).
- **Internal leakage.** If no out-leakage is observed, are there other internal pathways and compartments where the oil might have gone? Look for rising fluid levels in these zones and compartments.
- **Gear climbing.** Oil lifters, including paddle gears, slingers/flingers and the rotation of moving parts (gearing in particular) all draw oil out of sumps and reservoirs and lower the apparent oil level during machine operation.
- **Oil pump out.** After startup, oil reservoirs can go down as the pump fills system lines and cavities such as gear cases, bearings, oil galleries and distant oil ways.
- **Bleed purge.** Hydraulic and circulating systems often have bleed valves that when opened allow trapped pockets of air to purge and become replaced by oil. This draws the oil level down the reservoir.
- **Aeration and foam.** Foam, in particular, lowers the liquid portion of level gauges, sometimes substantially. When the foam collapses (e.g., when the machine is at rest) the correct level should return unless foam was pushed out of vents and other headspace openings.
- **Excessive misting and volatilization.** This is a form of out-leakage from various causes, such as the wrong oil (e.g., wrong viscosity), high temperature, excessive agitation, headspace vacuum, atomization/sprays or aeration.

Oil Too High or Too Low:

The following conditions can cause the oil level to appear to be too high or too low.

- **Air currents.** Strong air currents moving across vents and headspace openings can alter the oil level in the gauges. When the air currents stop the oil level returns to normal.
- **Mechanical agitation.** High speed mechanical agitation, including rotation, can push oil towards or away from the level gauge ports.
- **Temperature.** Hot oil and machine temperatures cause thermal expansion of lines, reservoirs and galleries. Extreme cold conditions do just the opposite.
- **Cylinder actuation.** Both single-acting and double-acting hydraulic cylinders change the oil level in the tank up or down depending the direction of actuation.
- **Reservoir pressure.** Some reservoirs have positive headspace pressure (nitrogen or instrument air for instance) and others have negative pressure (extraction fans for instance). This can move the oil level slightly.
- **Sump or machine level.** If the sump or the machine is off level, perhaps on a slope, this will affect the apparent oil level of the sight glass. This is common with mobile equipment.

Two Level Gauges are Better than One

It is a good practice to have an oil level gauge on both sides of some centrifugal

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Publisher
Udey Dhir - udeydhir@tribologysolutions.com

Creative Director
smassociates@gmail.com

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

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

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

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

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

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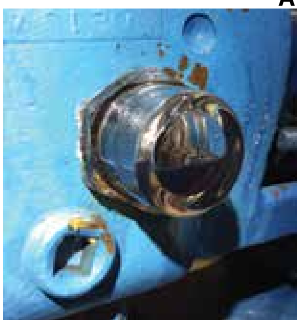
pumps. If the pump is not centered in the casing, the oil level will not read correctly in the sight glass due to oil movement by the bearing. However, if you have two level gauges, an average of the two readings will give a better estimated oil level. *ML*

Q: Which of these slight glasses is better for detecting fluid level for oils that are colorless (clear and transparent)? Which is better for detecting aeration and foam?

A



B

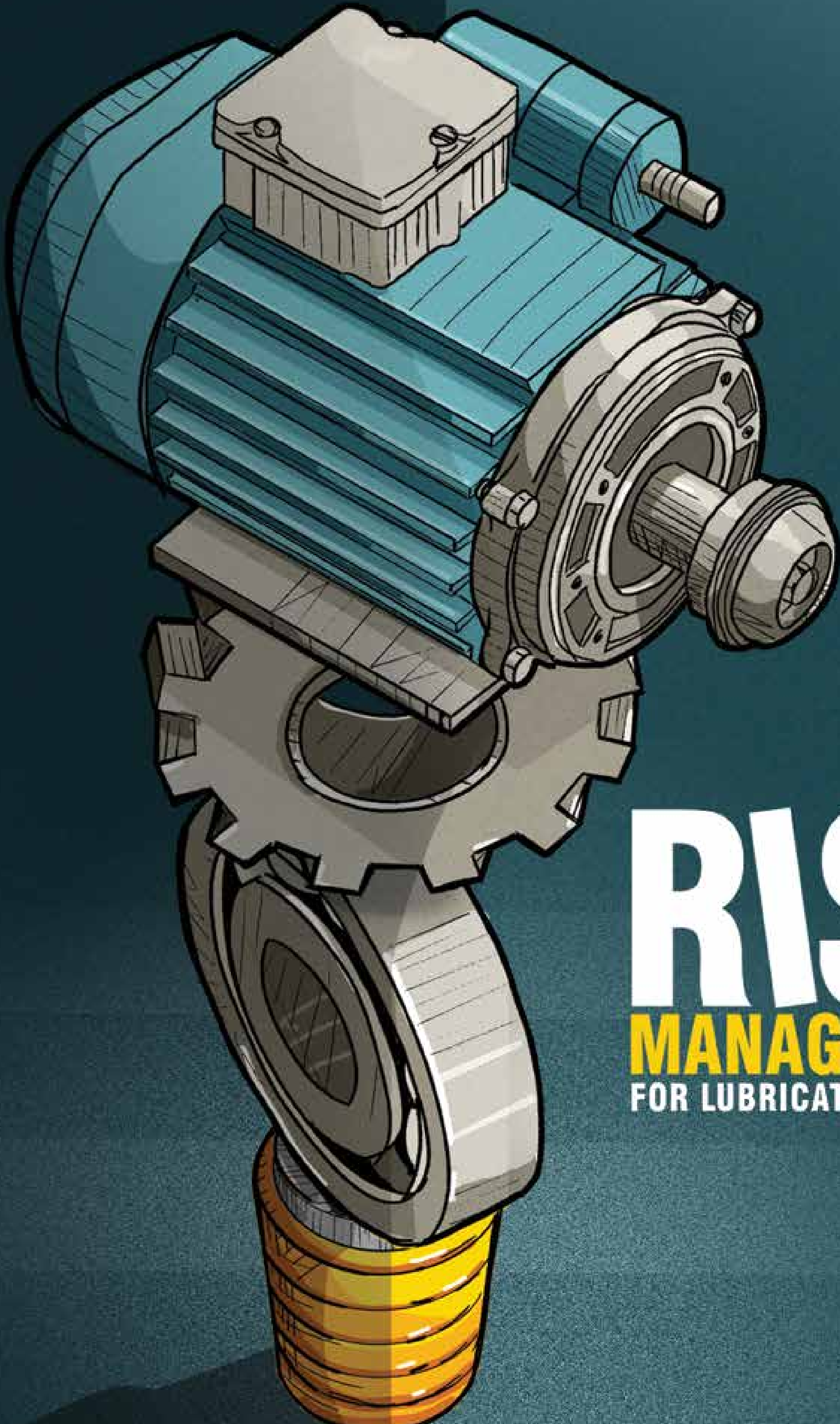
C

A: The answer is A for both questions. Sight glass A can be viewed from any angle and produces a large top oil surface. It uses a port that is centerline with the oil level in the sump. This allows foam and rising air to be instantly observed. Sight glasses B & C use ports positioned well below the oil level. Sight glasses mounted below the oil level will not effectively trap rising air and foam for visual inspection. Additionally, such columnar sight glasses require adequate ventilation.

About the Author

Jim Fitch has a wealth of "in the trenches" experience in lubrication, oil analysis, tribology and machinery failure investigations. Over the past two decades, he has presented hundreds of courses on these subjects. Jim has also published more than 200 technical articles, papers and publications. He serves as a U.S. delegate to the ISO tribology and oil analysis working group. Since 2002, he has been the director and a board member of the International Council for Machinery Lubrication. He is the CEO and a co-founder of Noria Corporation.
Contact Jim at jfitch@noria.com.

By Bennett Fitch, Noria Corp



RISK MANAGEMENT FOR LUBRICATED MACHINES

A central component to plant reliability is identifying and managing the risk associated to the equipment within the plant. As one gets entrenched in the vast amount of technologies and methodologies to increasing the plant reliability, each possible effort must be judged by the analysis of the benefit and the cost associated to achieving that benefit. This cannot easily be done without an understanding of the equipment's propensity to fail. A failure might be a complete loss of productive function or could simply be a reduced productivity or exposed hazard to the surroundings. For the essential equipment in a plant, lubricated machines are of particular concern because they tend to represent the assets that have moving parts, which introduces more dynamic fail points. Or in terms of plant reliability, lubricated rotating equipment represents a subset of plant assets that are by default at higher risk. For this reason, reliability engineers often put an emphasis on risk analysis and risk mitigation on lubricated rotating equipment. These efforts over the decades have resulted in many proven methods to narrow down which machines are most at risk, meticulously analyze the degree of risk and solutions to mitigate this risk.

One way to better understand the concept of risk for lubricated machines is to see it as a product of two variables: (1) the probability of failure and (2) the consequence of failure. This can be analogous to a person standing on the edge of a cliff.

Risk = The Proababilty of Failure x The Consequence of Failure

First, the probability of a person falling off that cliff is characterized by questions such as: How close is he to the cliff? How steep is the slope at the cliff? Are there guardrails? Is this a young reckless person or is this a rock climber experienced with cliffs?

Second, the consequence of failure can be characterized by questions such as: How high is the cliff? Are there rocks or deep water at the bottom of the cliff? Is there a safety net at the bottom? Is this person an experienced base jumper with a wingsuit? With this combination of questions, one can assess whether that cliff daredevil is at risk or not.

The same types of questions can be asked for lubricated machines to assess their level of risk. Answering these questions are fundamentally what drives reliability-centered maintenance (RCM). When RCM is done effectively, there is a deep understanding of every relevant variable that can influence the plant's overall reliability and the goal of determining what can be done to maintain an optimized level of reliability.

Considering these two variables of risk, the probability that a lubricated machine will fail is irrelevant if there is no consequence. Similarly, the consequence of failure is irrelevant if the machine cannot fail, theoretically speaking. The two must be understood to manage the risk. When putting this into practice, here are some questions that might be asked to identify the risk associated to lubricated machines.

The Probability of Failure

- How well are the lubricated machines equipped with sensors, sight glasses, oil analysis and other feedback indicators to alert lubrication technicians of a potential failure mode?
- How well-equipped are lubrication technicians with the right tools and software?
- How well-trained are the lubrication technicians in lubrication best practices?
- How experienced are the lubrication technicians in observing and mitigating lubrication failure modes with proactive maintenance and predictive maintenance strategies.
- How is the culture of the lubrication team in promoting good lubrication practices and aiming towards continuous improvement?

The Consequence of Failure: If the lubricated machine were to experience a failure...

- How much does the replacement part cost? What is the availability of this replacement part?
- How much labor would be required? Can this work be easily scheduled?
- What is the time before this would impact production? What is the cost of this lost production? Are there backups to this machine?
- What other machines could be damaged or also experience a failure (as a chain reaction of failures)?
- Is the safety of anyone compromised? If so, in what way?
- Is the impact to the environment compromised? If so, in what way?

Pareto Principle

Have you ever taken a multiple-choice test where more than one possible answer was correct, but to get credit for the answer you had to choose the most correct answer? These types of questions are often missed; not because the test taker didn't know the answer but because the test taker was quick to select a "right answer" before reading all other options that may have included an even better answer.

It is not always easy to know what the right actions should be to improve the reliability of your lubricated equipment. Often times daily work tasks are decided based on a quick justification that an action will provide benefit. While this is good, is it the best, most beneficial action to take right now? Consider the Pareto Principle, often called the 80:20 rule. This principle suggests that about 80% of the effects are due to about 20% of the causes. For example, if we analyze all the possible causes of a machine failure, there is a select 20% of those that are the root cause for roughly 80% of the occurrences of failure. Those 20% are called the "critical few". If each reliability effort, including your time today, is focused on addressing the critical few, then in theory those actions are the most important things that one can work on today. But first, all the possible actions must be analyzed before knowing which one to select as the best action. Just like the multiple-choice question.

But there is one problem… what exactly are these "answers"? What are those "critical few"? For lubricated equipment, this might simply mean focusing on a specific set of machines deemed as the most critical in the plant. Or when looking at root cause concerns, adjusting plant-wide reliability focus to target a certain type of contaminant that is known to cause the largest number of contamination related failures. Fortunately, many of these justifications are well documented for the general case. For example, the critical few reasons why bearings fail are improper lubrication and contamination. More specifically, an article from *Machinery Lubrication* magazine in 2009 titled "Lubricant Failure = Bearing Failure" identified how improper lubrication failure is responsible for 40-50% of bearing failure. This includes lubrication failure modes such as:

- Improper lubricant selection, such as incorrect viscosity selection or grease thickener type
- Improper lubricant quantity, such as over- or under-greasing a bearing
- Contamination, such as dirt ingression from bearing seals
- Excessive temperatures, as a root cause, or part of a symptom from a different lubricant failure mode

Reliability-centered maintenance uses at risk management as a reliability tool. The lubrication-related risk identified for machines helps justify a cost-effective strategy to avoid critical equipment from experiencing costly failure modes. Once the lubrication failure modes are identified, the following questions need to be assessed to ultimately rank their associated risk to the plant:

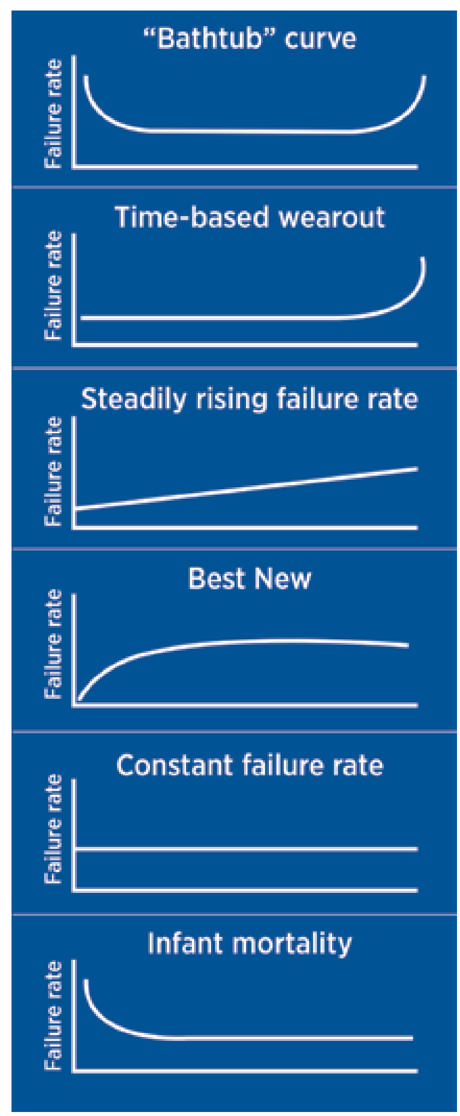
- Which assets exhibit the greatest potential consequence if a failure event occurs?
- What is the relative severity of the consequences?
- How likely are these failure modes to occur?
- What can be done to prevent these events?

When following RCM, the three phases (Decide, Analysis, Act) provide a structure to be followed during implementation. In a recent Reliable Plant article on "How to Implement Reliability- Centered Maintenance" by Jonathan Trout, he best describes some important aspects on how to implement reliability-centered maintenance.

Failure Patterns

Machine failures can often seem random. This can seem even more true when analyzing a single failure event or looking at only fragments of information on failure events. Being effectively proactive about avoiding machine failures requires a view into the future. Maybe not literally, but creating a prediction of a future failure on your equipment can be greatly enhanced by understanding the patterns of the past and envisioning those patterns extend onwards into the future. Some patterns can be easy to spot, but in many cases the many known and unknown variables that go into a potential failure mode make it difficult.

Recognizing failure patterns for lubricated machines has been done for decades

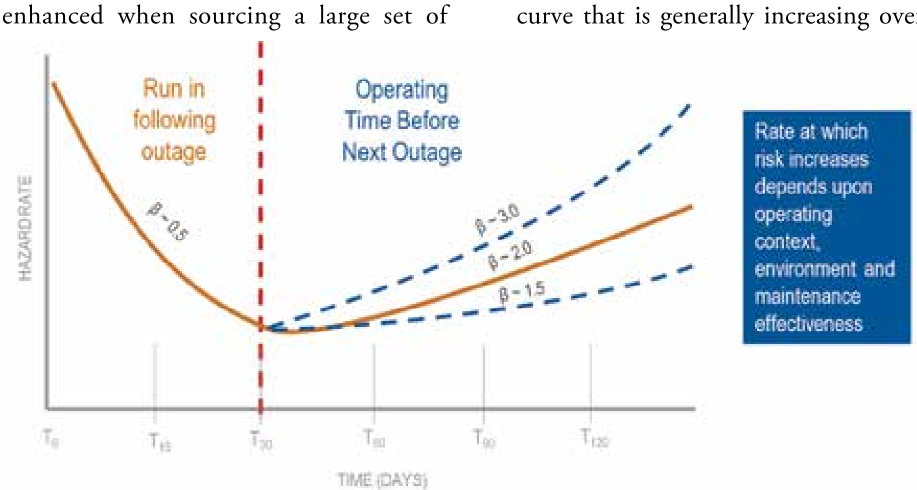


and proved instrumental in improving reliability from the design improvements, better identifying operating limitations and including maintenance recommendations. Some patterns are straight forward, such as a steadily rising failure rate that increases as time progresses. Others create predictions based on a known time where the likelihood of the failure will spike dramatically, known as the time-based wear-out.

The bathtub curve is an often discussed failure curve that incorporates a few different failure patterns together. On the front end is the possibility of infant mortality, that suggests machines have a higher propensity to fail upon startup due to manufacturing defects, installation errors, initial lack of internal cleanliness or other built-in problems. Once a certain time has passed, the failure due to one of these causes drops dramatically. This middle period can be a long time and if a failure were to exist, it may be due to operational factors or uncontrolled contaminant exposures. On the back end of this curve, towards the end of life, the machine may once again experience an increase in failure rate. This can be due to an expected time-based wear-out or the steadily rising failure rate that eventually.

The credibility of a failure pattern is greatly enhanced when sourcing a large set of data from similar machines with similar conditions. The failure rate is defined as the number of failures divided by the total running time. This is the inverse of a similar commonly used term, mean time between failure, or MTBF. The better the quality and greater the quantity the data, the more effective tool these failure patterns can be. When determining the probability of failure for a specific machine, the best data comes from analyzing the past failure from similar machines at the same plant under similar conditions. One effective technique used to analyze failure analysis data is called Weibull analysis or Weibull distribution. The steps of this technique start by creating a plot of past failure and/or current operation data on a Weibull graph (special log-based graph paper) to determine a shape parameter, β. This shape parameter can then be used to visualize a different failure rate curves that represent either an increasing failure rate ($\beta > 1$) or decreasing failure rate ($\beta < 1$). Some examples of some failure rate curves to graphically visualize failure or life characteristics of the machine are:

- **Weibull probability density curve** – a curve that is generally shaped like a bell curve representing the probability of failure (y-axis) to occur a specific period of time (x-axis).
- **Cumulative Density Function** – a curve that is generally increasing over time that shows the probability of failure (y-axis) to occur before a period of time (x-axis).
- **Weibull reliability** – a curve is generally decreasing over time that shows the change in reliability (y-axis) during a period of time (x-axis).
- **Weibull hazard rate** – a curve that is generally increasing representing the increasing failure hazard (y-axis) over a period of time (x-axis) that is also often considered the failure rate.



One of the greatest benefits of analyzing the Weibull distribution of a failure mode is determining the risk level associated to a lubricated machine, even though the failure rate is constant for a period of time. The failure curves are often determined using empirical data, but when analyzing the actual cause of failure, then one must look at influencing variables such as those related to operating conditions, environmental conditions, maintenance history, or machine design defects. Having an analysis technique on these possible contributing factors is necessary.

FMEA

Failure mode effects analysis, or FMEA, is a methodology developed over 50 years ago by NASA engineers during the space race. Their design practices had the goal of making every proactive effort to investigate all the possible ways the vessel taking man to the moon could fail and what could be done to avoid the failure. This methodology has since been used across industries to improve efficiencies in mechanical designs by using a thorough review process to identify every possible failure mode. During this design stage, lubricated equipment becomes more reliable before it is even in service. Failure modes considered are a function of more than just operating characteristics such as load and speed, but also the possible effects from environmental factors such as solid contaminants, moisture, external temperature extremes and even the possibility of misusing the equipment intentionally or unintentionally. In short, this becomes a review of the adage of Murphy's Law, determining what can go wrong, because ultimately it may very well be the reason for it to fail.

The result of performing an FMEA is about more than just identifying failure modes. This process considers the whole thought process that is required in reviewing the characteristics of each failure events, including:

1. **Defining the asset functions.**
   - Primary functions related to operational productivity.
   - Secondary functions related to safety and environmental impacts.

2. **Defining the state of functional failure for the asset.**
   - What constitutes a failure state?
   - What are the events the lead up to that failed state? (such as chain reaction)?

3. **Identifying the specific effects from the failure mode.**
   - What is the evidence of a failure mode?

4. **Identifying the root causes of the failure mode.**
   - What was the initial event that started the chain reaction leading up to the failure?

5. **Identifying the nature of each consequence as a result of a failure**
   - What is the evidence of a failure mode?
   - Production, safety, environmental, hidden, secondary chain reactions, etc.

6. **Identifying the risk related to each consequence**
   - What is the severity?
   - What is the likelihood?
   - What is the current state of detectability?

Each possible failure mode is analyzed under the scrutiny of these questions. Consider a lubrication-related failure mode, such as abrasive wear on a ball bearing. We must ask questions such as what was the reason why the lubricant failed to protect the bearing? Was it related to the lubricant properties or what is contaminant induced? Does this bearing failure result in significant set of consequences or is this bearing on a non-critical asset?

Once each failure mode is well characterized and well understood, then a risk assessment can be developed and used to prioritize the actions (if any) that need to be taken. Conclusively, this prioritization will justify the focus on what lubrication concerns are most important to address and in what order.

Hazard Analysis Critical Control Points

Another consideration when managing risk is the steps to routinely inspect machines for potential hazards. Hazard Analysis Critical Control Points, or HACCP, is a technique used in the food safety industries to do just this. HACCP is a program that focuses on examining critical control points in the production cycle of a food processing facility and determining if there is any known or reasonably foreseen hazards, such as health and safety risks, that could occur with the current configuration. Observations are made to consider any food contamination points throughout the process as well as any allergens that could cross contaminate foods and any sanitation risks. The HACCP program is monitored routinely and written down in detail to provide confidence of thoroughness. Programs like these have been successful in food processing facilities.

Risk: A Call for Action

Risk is all about analyzing the probability of failure and the consequences that result from a failure. A failure does not have to be a full seizure of a machine, it can simply be a reduction in intended function due to an expected cause. Or it can be the development of a health or safety concern. Lubricated machines are often of critical concern and potentially high risk due to the nature of mechanical design and vast use in industrial facilities. Even the use of lubricant itself can pose a risk to the surroundings, either to the health of those around or contamination to the environment. Ultimately, identifying what can be controlled and should be controlled may be crucially valuable in improving the reliability of machines and overall wellbeing. Managing this risk by taking these key proactive and preventative actions to minimize or eliminate these risks is our call for action. ***ML***

About the Author

Bennett Fitch is the director of product development and lubrication program development (LPD) services for Noria Corporation. He is a mechanical engineer who holds a Machine Lubricant Analyst (MLA) Level III certification and a Machine Lubrication Technician (MLT) Level II certification through the International Council for Machinery Lubrication (ICML). Contact Bennett at bfitch@noria.com.

Jack Weeks | GPM Hydraulic Consulting

Distinguishing Regulators and Reducing Valves

" The regulator is designed to control pressure in a gas medium while the pressure reducing valve is intended to operate with a liquid. "

We have seen a lot of confusion about pressure reducing valves and regulators in fluid power systems. This confusion is largely due to the nomenclature and partly because the schematic symbols are not always as intuitive as they could be. The valves themselves are actually fairly simple. In a pneumatic system, the valve is called a regulator. In a hydraulic system, it is called a pressure reducing valve. Notice that the symbols are quite similar, because their function is the same, only with a different medium. **In Figure 1, the two symbols are shown side-by-side.** As in most fluid power pressure controls, the regulator and the pressure reducing valve are characterized by a single square with a single arrow drawn inside. We can see that the only difference between the two is that, in the pressure reducing valve, the arrowhead is filled in, whereas in the regulator there is only the outline of an arrowhead. This is to illustrate that the

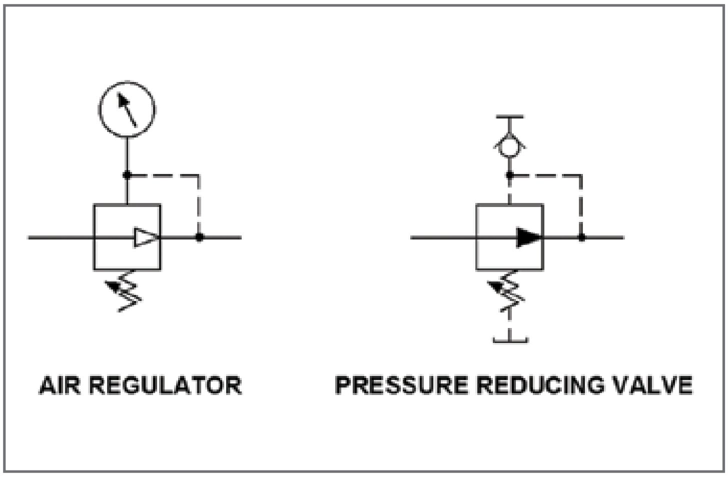


Figure 1. *Symbols*

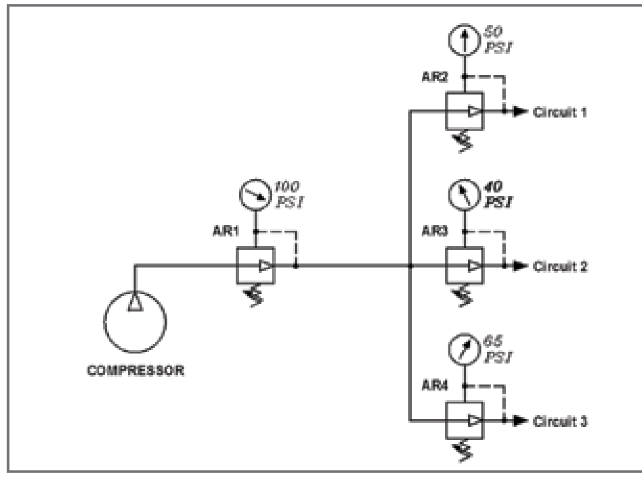


Figure 2. *Secondary regulators*

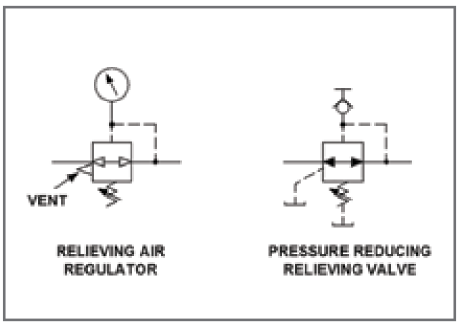


Figure 3. *Increased pressure*

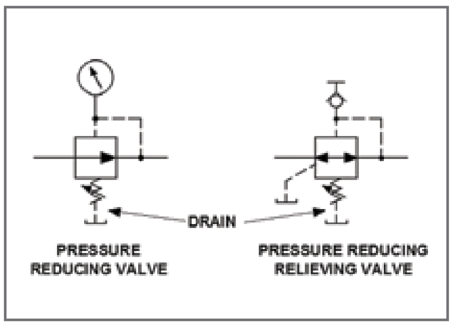


Figure 4. *External drain line*

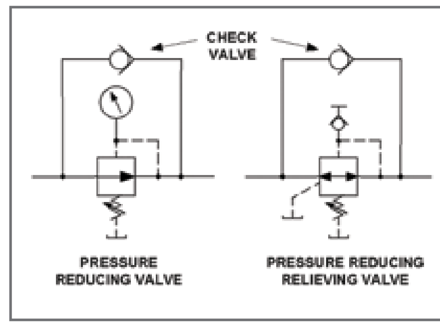


Figure 5. *Bypass check valve*

regulator is designed to control pressure in a gas medium while the pressure reducing valve is intended to operate with a liquid.

Both of these valves are normally open, which is indicated by the arrow touching both the inlet and the outlet ports. On the bottom of the symbol is a jagged line representing a spring. If the spring is adjustable, a diagonal arrow will be drawn across it. A good way to think of the valve when tracing flow on a schematic is to consider the spring pushing the arrow up and holding the valve open. But, in order to reduce the pressure, the valve must close off to some degree.

Notice the downstream pilot line. System pressure is measured downstream of the valve and applied to the top of the arrow, pushing it down and partly closing the valve. When the two forces equalize, i.e. spring tension on the bottom and air or hydraulic pressure on the top, a balance is achieved and the pressure is reduced.

The air valve is called a regulator, but even though the name suggests that it can either increase or decrease the pressure, like the pressure reducing valve, it can only decrease the inlet pressure. In a pneumatic system, the regulator is the primary pressure control. The compressor will determine the maximum pressure and the regulator reduces the pressure to a level that is safe and usable, opening and closing as necessary to keep the pressure stable. **While there may also be secondary regulators to lower the pressure further for use in branch circuits as shown in Figure 2, there will always be a primary regulator to stabilize and set the main system pressure.** In a hydraulic system, pressure reducing valves are used to lower the system pressure for use in circuits that require less pressure than the maximum system pressure. This extends the life of the lower pressure circuits and conserves energy.

Though often not shown on the schematic symbol, most pneumatic regulators are of the relieving type. The advantage of this type of regulator is that it not only can reduce pressure in the system but can also allow any excess to escape. With a non-relieving regulator, it is possible for air to become trapped in the circuit, keeping the valve from reducing pressure. In the relieving type, if the downstream pressure ever exceeds the spring tension of the valve, a vent opens to release the trapped air. The non-relieving type are usually only found in systems using gases that are either too toxic or too expensive to be released to atmosphere.

The corresponding hydraulic valve is called a pressure reducing relieving valve. The reducing relieving valve is used in hydraulic circuits where it is essential that the downstream pressure never exceed the spring setting but opposing forces may act against it. They are quite common in paper machines, for example, where it is necessary to maintain precise force, even if some imperfection is encountered that forces a cylinder to retract slightly. The pressure then builds briefly downstream of the valve, causing it to shift into its relieving mode once the pressure exceeds about 3-5% of the spring tension. **In Figure 3, imagine the downstream pressure being maintained by the spring tension of the valve, but a reverse force raising the pressure briefly causes the valve to shift to its relieving mode.** In the case of the air regulator, the arrow gets pushed down past the vent port and air is released immediately to atmosphere. In the hydraulic pressure reducing relieving valve, the increased pressure in the pilot line forces the arrow down to release hydraulic fluid to tank.

Another characteristic to note in both the hydraulic pressure reducing valve and pressure reducing relieving valve is the external drain line as shown in Figure 4. This drain line must be present in all hydraulic reducing valves so that oil bypassing the internal spool has a flow path to tank. Whenever the reducing valve's outlet pressure is below its inlet pressure, drain oil flows. If the external tank line becomes plugged, the valve cannot shift freely and pressure will not be controlled. Whenever the valve is replaced, the drain line must be inspected to ensure that it is clear. These valves are often replaced unnecessarily because the drain line has become plugged. The new valve will function for a short period until bypassed oil collects in the valve and keeps it from shifting.

These pressure controls are designed to function in one direction only. **If they are installed in a line where fluid may be directed in either direction, there must be a bypass check valve to allow free flow in the opposite direction as shown in Figure 5.** When troubleshooting the valve, be sure to inspect the check valve (if it is present) for trash. Typically, when check valves fail, they fail open. If the check valve becomes stuck open, the reducing valve will no longer be able to control pressure. ***ML***

Abdullah B. Samman, Hasanur J. Molla | Saudi Aramco

Measuring the Effectiveness of Vacuum Dehydrators

" Water is considered one of the biggest enemies of rotating equipment and their lubrication systems. "

Lubricant fluids are carefully formulated for specific areas of application and are comprised of a base stock and an additive package. The additive package consists of chemical compounds designed to protect the base stock, as well as system components and to ensure proper performance of the system.

Water is considered one of the biggest enemies of rotating equipment and their lubrication systems. The presence of water in a lubrication system can result in many problems such as corrosion of equipment, depletion of additives and loss of oil lubricity. These problems could lead to accelerated wear of internal components and irreparable damage to the equipment. In addition, lube oil life can be significantly reduced when mixed with water even at low concentrations due to accelerated oxidation. Therefore, removal of water in lubrication fluids is extremely important as soon as identified via laboratory testing.

Water contamination can arise from several sources including leaks from inadequate sealing surfaces, condensation of humid air or from open reservoirs. In addition, a reduction in temperature of the fluid can lead to the generation of free water from dissolved water. Each fluid type has a typical water saturation profile based on the base stock, additive package and presence of degradation by-products.

This article discusses the effectiveness of a vacuum dehydrator to remove water contamination from lubricating oils and if there are any degradation effects of the oil.

Forms of Water Contamination

Water can exist in oil systems in three distinct forms: Free, emulsified and dissolved water. Table 1 highlights the differences between these three forms.

Vacuum Dehydrator

Vacuum dehydrators work by

Form of Water	Free Water	Emulsified Water	Dissolved Water
Description	Water content well above fluid saturation point. Water exists in the form of a completely separate layer with the oil.	Water content above fluid saturation point. Water is emulsified with the oil, forming a cloudy mixture.	Water content below fluid saturation point. Water is solubilized in the oil, resulting in a clean and normal looking lubricant.
Impact	Severe Rusting Lube oil degradation	Rusting Clogged Filters Improper lubrication Lube oil degradation	Additive depletion Lube oil degradation
Method of Separation	Draining via gravity Centrifuge Coalescers Cellulose Media Vacuum Dehydrator	Offline Filtration (Centrifuge, Cellulose Media, Vacuum Dehydrator)	Offline Filtration (Vacuum Dehydrator)

Table 1. Types of water contamination in oil.

heating up the oil while simultaneously drawing a vacuum. When the oil-water mixture is exposed to a vacuum, the boiling point of water is reduced. This allows the water to flash via the heat into vapor, which is then recondensed, to be rejected from the system.

Because the boiling point of water is reduced, this allows the oil to be heated to a temperature low enough to stop thermal breakdown of the oil and additives. Vacuum dehydrators also have the advantage of removing all forms of water, including dissolved water, which is not possible through other typical water removal purification systems, such as coalescers and centrifuges. Figure 1 displays the different components in a vacuum dehydrator.

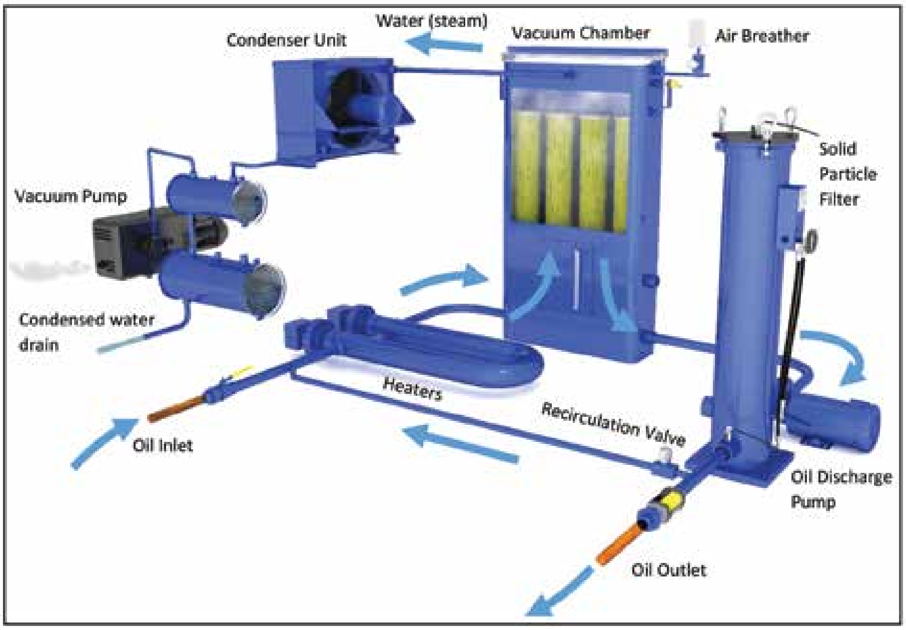


Figure 1. Vacuum Dehydrator system components. (Courtesy of Hy-Pro Filtration)

Vacuum Dehydrator Experiment

Machine: Steam Turbine Vacuum
Dehydrator run: 60 Hours
Start Date: February 29
End Date: March 3
Sump Size: 1500 liters
Capacity of Vacuum Dehydrator: V10
Set Oil Temperature: 50°C

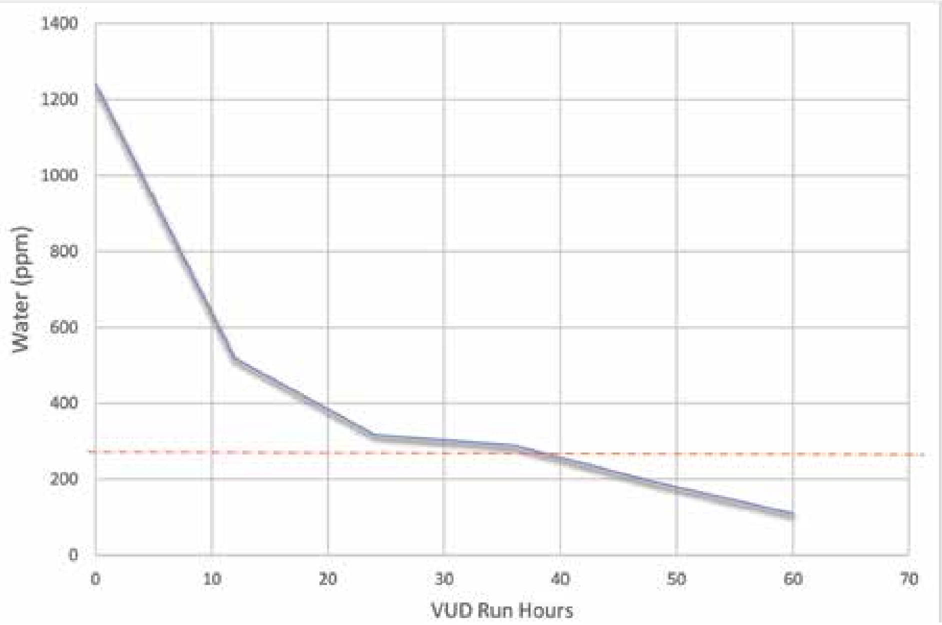


Figure 2. Concentration of water vs. running hours of vacuum dehydrator.

The subject machine was found with high water content (1250 ppm) in the lube oil system through the condition monitoring program. The root cause was attributed to leaking seals. Hence, it was decided to utilize this equipment for the trial. The turbine was kept in shut down during experiment to stop further water ingression through leaky seals and properly understand the effectiveness of vacuum dehydrator.

For this trial, a portable vacuum dehydrator was used. It was connected to the lube oil reservoir as a kidney loop filtration system. The temperature was set at 50°C during purification. The purification process was continued for 60 hours and water content and AN were measured for oil samples collected every 12 hours during purification. The rotating pressure vessel oxidation test (RPVOT) was also measured for new and used oil before and after purification.

The results are captured below:

- **Water (ppm):** Water content was reduced from 1250 ppm to 250 ppm within 25 hours of operation and it took 35 additional hours to further reduce the water content from 250 ppm to 100ppm. The saturation point of the used turbine oil was around 250 ppm and is highlighted in the graph with a dashed line. Therefore, free water and emulsified water can be removed rapidly from the lube oil by the vacuum dehydrator. It is time consuming to remove dissolved water from lube oil.

The results are captured below: (continued)

- **AN (Acid Number):** There was no significant impact on the AN of the turbine oil from running the vacuum dehydrator. It fluctuated from 0.07 to 0.08 mg KOH/gm from the start to the end of the purification process.
- **RPVOT:** The new oil had a higher RPVOT value than the used oil as usual. There was no significant change of RPVOT for the turbine oil at the beginning and end of the purification process by the vacuum dehydrator.

An experimental trial was conducted on a Saudi Aramco gas turbine that had unacceptable levels of water contamination in its lube oil.

The purpose of the trial was to test the effectiveness of water removal from lube oil using vacuum dehydration.

Looking at the results, the vacuum dehydrator was effective in removing all forms of water contamination from lube oil. Within 60 hours of operation, it was possible to reduce the water content from 1250 ppm to 100 ppm, which is way below the 250 ppm saturation point of the turbine oil used in this gas turbine.

The water removal rate is relatively slow once the concentration drops below saturation point and therefore it is economical to stop the vacuum dehydrator after achieving water contamination below the saturation point. The vacuum dehydrator does not degrade lube oil during the purification process and there was no significant impact noticed on the AN and RPVOT of the oil. *ML*

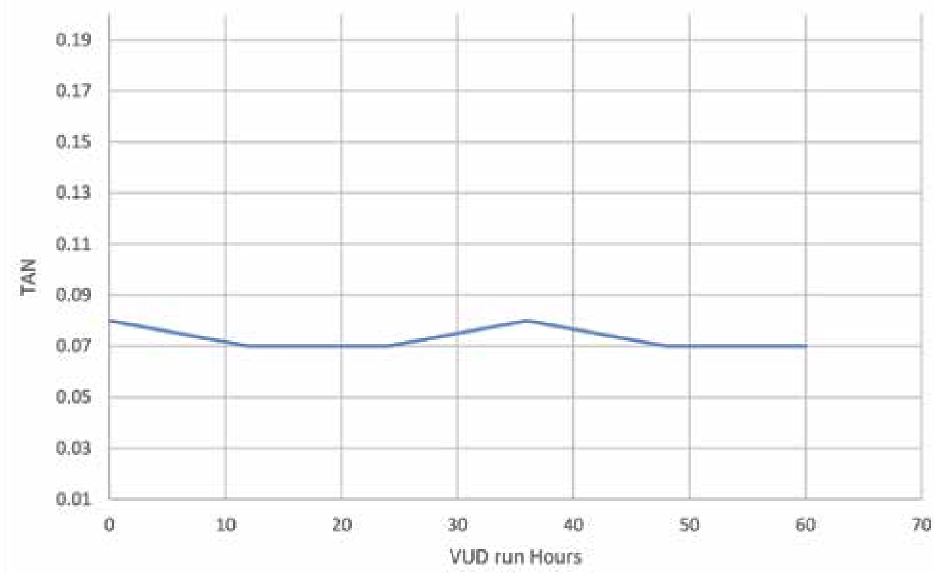


Figure 3. Effect of vacuum dehydrator on oil AN

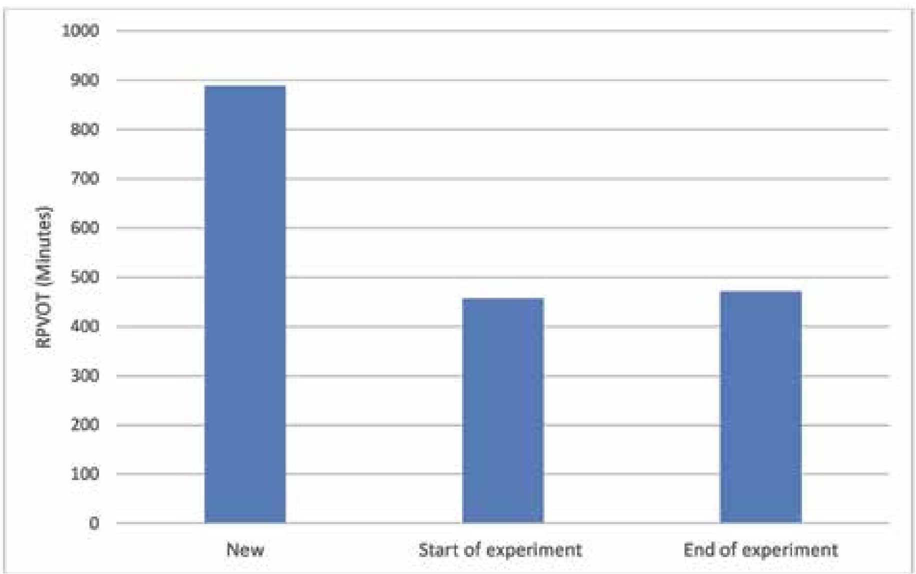


Figure 4. Effect of vacuum dehydrator on RPVOT.

Figure 5. Vacuum dehydrator (Hy-Pro Filtration. Used with permission)

Strategies for Decontaminating and Reclaiming **Your In-Service Lubricants**

" Lubricating oils in large-volume systems can have a long service life. Some may be in service for 15 to 20 years. "

At most plants, oil reclamation is not fully supported due to a lack of technical knowledge and availability of technologies, processes and applications. Why should reclamation be considered? The process has evolved over the years through rigorous oil testing and compatibility analysis of in-field trials. The advances and scientific support now available have led to robust reclamation technologies and processes. However, it is important to understand the limits and boundaries.

Past experiences and practices often lead to oil being changed on a timed interval or based on oil analysis results. Few managers want to be accountable for the risk of using new and emerging methods. Therefore, changing the oil and flushing the system are frequently the chosen approach.

Lubricating oils in large-volume systems can have a long service life. Some may be in service for 15 to 20 years. Many of these oils are made from Group I or II base stocks, unlike the more robust Group III or polyalphaolefin (PAO) base stocks. What makes these lubricants last so long? A historical review of the data from these systems reveals the oils operated within the set parameters, specifically temperature and contamination. Additive content remained healthy and the base oil was protected. The oils also were not significantly stressed.

Other systems that experienced significant problems were also reviewed. These included labyrinth seal issues, higher temperatures, filter decay and breakdown, process gas and steam ingress and poor maintenance practices. In these cases, the oils operated in highly stressed environments and were exposed to heat, water, solid contaminants and chemicals. Costly firefighting strategies were also employed, such as filtration systems, vacuum dehydrators and "sweetening" of the oils.

For organizations desiring to mitigate further problems, there is good news. Some solutions have a much longer duration than others, depending on operations, availability of spare parts, maintenance plans and the establishment of long-term objectives. For lube oil, detailed analysis is required to determine its life. Some oils will be fit for use, while others must be changed.

Unfortunately, few companies are focused on reclaiming their oils when the base oil is not compromised, which can only be verified through base oil testing. Reclamation normally will involve the removal of precursors along with the addition of additives, typically antioxidants for turbine oils. The addition of these antioxidants should be validated by compatibility testing. Three case-study examples are detailed below.

Case Study #1: Petrochemical Plant Turbine A

The reservoir size of this particular turbine was 2,800 gallons. The lube oil system was well maintained and had a nitrogen purge on the headspace. The system filtration used 5-micron absolute filters. Oil was changed based on a timed interval and supported with routine oil analysis. The rotating pressure vessel oxidation test (RPVOT), remaining useful life evaluation routine (RULER) and membrane patch colorimetry (MPC) are conducted twice a year. The system has been in service for 12 years with no oil changes. Typical results would include an RPVOT value greater than 1,100, more than 55% remaining useful life on the RULER test and an MPC value of less than 10.

Case Study #2: Petrochemical Plant Turbine B

The reservoir size of this reservoir was 2,200 gallons. The lube oil system was more than 30 years old. The system's filtration used 25-micron nominal cotton-wound cartridges. The reservoir headspace had a dehumidifier, which had been problematic. Due to a labyrinth seal problem, there was a constant steam leak. The system experienced significant lube oil challenges. Typical results included an RPVOT value of 700, 30% remaining useful life, an MPC value of 35 and a viscosity change of more than 3% every six months.

"Sweetening" of the lube oil was frequent. Varnish was prevalent. The system had a vacuum dehydrator and a balanced charged agglomeration varnish removal unit. The dehydrator significantly reduces moisture to below 300 parts per million (ppm) and varnish below 20. Without the vacuum dehydrator, moisture will increase significantly and has exceeded 10,000 ppm. Operators have daily noted, a strong ammonia scent from the dehydrator's vacuum pump exhaust.

Case Study #3: A Centrifugal Compressor

The in-service oil of this compressor did not meet specifications as required by the original equipment manufacturer (OEM). Oil analysis results showed an RPVOT value of 900, 50% remaining useful life and an MPC value of 15. The company did extensive testing on the compatibility of the oil with the addition of an antioxidant. The lab results were very favorable. Antioxidant was added under the supervision of the supplier. Oil testing was conducted for a period of one year with favorable results.

Analysis

Case study #1 is a clear example of a well-maintained system. The system was well designed with best practice methodologies. Opportunities for ingress have been eliminated. But more importantly, the system is well maintained. Abnormalities were addressed with urgency. Reclamation was not required. Decontamination has been maintained by the system's filtration. The company has invested in training, certification and has partnered with equipment OEMs for maintenance.

Case study #2 identifies a situation that is chronic. Other factors unknown are the availability of spare parts or the availability of resources to address issues. The situation is a common "firefighting" situation with no clear objectives. Viscosity changes are forcing "oil sweetening" strategy to be executed periodically. Reclamation cannot be considered as the base oil has been damaged. The equipment is the oldest of these three scenarios.

Case study #3 identifies a system problem that has been allocated resources to identify the root cause, with intervention of a long-term solution. The cost associated with this process is considerably higher than scenario two but has lower cost of ownership. Again, it is important to consider all factors including context. The reclamation strategy examined the addition of antioxidant under robust supervision of the management team in partnership with the supplier. This strategy is still uncommon but is gaining momentum as references are increasing worldwide. It is an option that is available for consideration for large turbine oil users; something that would not have been considered many years ago.

In summary, reclamation is becoming visible to turbine oil users. As references increase, the risk reduces and users explore their options. It is mandatory that lube oils are tested to ensure they are fit for reclamation as well as to ensure that the reclamation process has been successful.

Decontamination

Decontamination has been a focus for many in the past with great emphasis on filtration technologies from numerous vendors worldwide. Some have benefitted significantly while others have been "stuck in the middle" with no clear objectives. Some lack understanding of decontamination processes and technologies available.

Some of the more common contaminants frequently found in lube oil systems are water/moisture, solid particles, process gases, high temperatures and varnish deposits. Ingress of these contaminants has detrimental effects on lubricants and equipment components. Most times these effects are long term with progressive deterioration that can potentially lead to failure. However, some consequences are immediate and can be catastrophic.

Using best practices, systems can be designed or modified to exclude contaminant ingress. Among the areas of contaminant ingress to review include gaskets, worn or damaged seals, open hatches and pipes, dirty hoses, dirty top-up containers and dirty new oil.

Focus is required on the types of contamination that is in a lube oil system. Firstly, examine oil analysis reports and review any abnormalities. Look for data changes and trends (both increasing and decreasing). If a report provides cautionary or critical warnings, it must be investigated further. Resample and retest the lube oil. A retest will confirm accuracy of the results and can prevent unnecessary actions.

In the absence of oil analysis reports, take alternative options such as using your senses. This is by no means best practice. Use your sense of touch to feel for tacky, thin or solid material. Use your sense of smell to detect fuel, process gases, burnt, foul or pungent odors. Use your vision to look for water, foam, air bubbles or a cloudy or dark appearance.

For solid contaminants, another alternative is to conduct a field patch test. This provides a great snapshot of solid contaminants in the lube oil sample. However, particle counting is the best practice available. Particle counting provides counts of actual particles identified in the range numbers of the ISO code. This is very helpful in selecting filters required to remove solid particles.

Once contaminants are determined, it is imperative to remove these as soon as possible. Following are some of the most popular methods for removing these contaminants.

Water

Water and heavy solid particles will naturally settle at the bottom of reservoirs. If oil analysis results identify high levels of moisture beyond specified limits, it must be reduced. For applications with large ingress of water, a centrifuge will be very effective. However, it will not remove moisture below the saturation point. For lube oils, it is best to remove moisture to as low as reasonably possible. Therefore, in most situations, a vacuum dehydrator is used to remove large volumes of water and to meet moisture limits of the oil. In the situation where there is a coolant leak or steam leak, moisture ingress maybe continuous. A balance will have to be achieved with a vacuum dehydrator to ensure that moisture limits are maintained. Dry air and nitrogen are best suited for maintaining lube oils with existing low moisture levels.

For vacuum dehydrators, the technology has evolved significantly. Most systems utilize low wattage density heaters. This prevents lube oils from becoming burnt as it passes over these heaters. Vacuum pumps have improved significantly resulting in more reliable operations. Foam sensors have also been included with controls to avoid foaming. This reduces the risk of vacuum pump failure and oil spills. Vacuum chambers' designs have been improved resulting in improved mass transfer efficiency. Vacuum dehydrators are

becoming more reliable in the industry.

Gases

Most times these gases are directly related to process gases. They are typically dissolved and can be easily removed using vacuum dehydration. Note that some gases are dangerous. In this case, the vacuum pump exhaust must be vented to a flare.

Solid Particles

These particles are removed via filter media. The choice of media can be challenging, as they vary in performance. However, a logical process should be adopted where filters are selected on the type and number of particulates to be removed.

There isn't a simple process to the selection. However, obtain a current particle count with particle distribution. This will give you an indication of particle size and quantity.

If filtration is offline with easy access to change filters, then lower cost filters can be explored. Start with the micron size in abundance and remove these particles. Then replace with a lower micron size. Change filter based on recommended differential pressure or filter indicator. Repeat process until particle count is acceptable. This will avoid using depleted multiple smaller micron filters which typically are more costly.

For pipeline flushing, screen mesh or surface media can be used initially to remove the bulk contaminants followed by standard filtration.

Efficiency or beta ratio is sometimes not well understood. Some manufacturers state their filters are high efficiency or absolute rated. Unfortunately, there is no standard that identifies an absolute rated filter. Best practice recommendation is to review performance curves of each filter. Higher efficient filter will capture more particle of a specific micron size in one pass. This type of filter is necessary if lube oils will be pump directly to lube oil components after the filter. They are not recommended for recirculation systems.

Dirt-holding capacity can be used to determine the cost of filtration based on the number of filters expected to be used.

High Temperature

For systems with high temperature, many factors need to be reviewed. These include the use of vibration analysis, infrared thermography and airborne ultrasound. Related symptoms are normally beyond the lube oil system. However, the coolant system periodically clogs with minerals. In this case, the coolant system must be flushed.

Varnish

Varnish has become prominent in many lube oil systems. There are many precursors to the development of varnish from high heat, contaminants and base oil stocks. In many systems, varnish deposits on machine surfaces can be identified by a very thin dark layer on tank walls, bearings/journals, valve spools and filters. This layer acts as an insulator leading to high temperatures. The effects can be devastating. To reduce varnish, many companies focus on varnish removal equipment. Note, many systems may not show any visible signs of varnish unless the system is shut down. Varnish can dissolve at higher temperatures. When the system is shut down the lube oil cools leading to varnish deposits on machine surfaces. Systems designed to remove varnish must be evaluated and considered with temperature in mind. It is recommended to conduct lube oil testing and analysis to determine varnish potential. Varnish can be reduced using technologies such as balance charged agglomeration, depth cellulose media and ion exchange. These technologies are available in units similar to offline filtration systems.

Roadmap Forward

A road map is provided as guidance to making decisions with large reservoir turbine oil systems. Both short- and long-term steps are provided.

Short Term

Step 1: Obtain oil analysis data and determine current issues.

Step 2: Based on existing KPIs, determine requirements to address current issues. These may include the operations schedule and budget, the maintenance schedule and budget, the required resources and associated costs.

Step 3: Obtain and implement the relevant resources. Test the lube oil and analyze the results. Repeat until the desired results are achieved.

Long Term

Step 4: Reassess existing KPIs and long-term objectives, such as oil testing, best practices, varnish mitigation, oil reclamation, filtration/dehydration, cooler performance, parts replacement and equipment modifications. Determine the resources required to implement recommended best-practice solutions. These might include training and certification, standardize procedures, parts replacement, equipment modification and implementation and the deployment of oil reclamation strategies. Finally, seek the allocation of funds for oil testing and analysis inclusive of varnish testing, additive health and base oils.

Step 5: Obtain budget approval.

Step 6: Implement resources.

Step 7: Monitor and reassess. Review the current oil analysis reports, maintenance and operations costs and program performance.

Summary

Turbine oils are critical to companies' operations. If not monitored and supported effectively, increased costs and potential failure remains eminent. Oil analysis is critical to understanding the health of lube oils and equipment. In some cases, the lube oil life has been exhausted. In many applications, lube oils can be reclaimed using detailed oil analysis together with the current technologies and solutions available today. It is mandatory that equipment users consider options to monitor and maintain lube oil health. Life extension and equipment reliability will be achieved and will become the new norm. Companies will be able to manage their core business at peak profitability. ***ML***

What to Expect from the MLE Exam

"Those who were expecting a challenge certainly found it.

With practitioners around the world now having taken the Machinery Lubrication Engineer (MLE) exam for more than a year, those interested in achieving this engineering-grade, management-level certification from the International Council for Machinery Lubrication (ICML) may be curious as to what the early adopters thought about their exam experience. Therefore, ICML contacted everyone who passed the exam in 2019 and asked a few key questions about their assumptions, expectations and difficulties.

Assumptions

When questioned about their assumptions for the exam, some test-takers found the online guidance ICML provided by linking to cross-referenced resource materials in all 24 areas of the MLE body of knowledge (BoK) to be quite helpful. Pathiri Sampath, senior condition monitoring tech at Qatargas Operating Co., studied the BoK as part of his strict regimen and indicated nothing surprised him about the exam's contents.

"ICML's website clearly stated about subjects and preparation," Sampath recalled. "It guided me to concentrate on (relevant) topics."

Another candidate unsurprised by the topical scope was Loren Green, senior technical representative with Industrial Oils Unlimited. Although the MLE is not a continuation of the Machinery Lubrication Technician (MLT) or Machine Lubricant Analyst (MLA) certification tracks, it does overlap content while also expanding into new territory.

"I expected that it would be a much broader view of lubrication overall, and it was," Green said.

Roger Story, maintenance manager at DSM Chemicals, discovered that his previous certifications helped pave the way for his MLE comprehension.

"I assumed that lower-level certifications such as MLA III and MLT II would be represented on the test, and that was correct," Story remarked. "My career as a reliability engineer prepared me for the rest of the exam."

Tough and Challenging

Just because the candidates thought the topical distribution in the exam corresponded well with the MLE BOK doesn't mean the actual questions met their expectations. A non-scientific survey yielded a consensus that the exam can offer both pleasant surprises and rude awakenings, even for the most experienced and prepared candidates.

Those who were expecting a challenge certainly found it. Michael Holloway, president of 5th Order Industry, assumed there would be a lot of material to absorb and remember, which he soon learned was accurate.

"The exam was a beast," Holloway said.

Nurudin Bn Mochamad Djamil, technical specialist for Pertamina Lubricants, had one word to describe the questions: tough. Petrosave Integrated Services' Nnamdi Achebe used that same word to explain his own experience.

"My assumption that it was going to be a tough exam proved to be very true," Achebe noted. "I used up the entire four hours allotted, and after that exam I felt mentally drained. I slept all through my travel back from Texas to New York on a Greyhound bus."

Jose Camilo Valest Sandoval, technical support engineer at Tritech, thought some of the questions dealt with details that caused him to struggle.

"I felt difficulties in topics of asset management, waste and used lubricant management, environmental compliance, and storage of spare parts conditions," he reported.

Because MLE content overlaps with oil analysis and lubrication practices covered in the MLA and MLT certifications, Sandoval realized he should have spent more time reviewing those basics rather than assuming such knowledge would come back to him during the MLE test.

"There were some basic concepts (e.g., about lubricant films) that I believed were learned, and I didn't give them enough importance," he added.

Oxy USA's Nathan Thomas agreed that the MLE questions address more of the lubricant life cycle than one might anticipate. He, too, was challenged on the same areas as Sandoval.

"I assumed the exam would require a relatively high-level understanding of the lubricant life cycle, especially around formulation and disposal as they relate to environmental and disposal concerns," Thomas explained. "(But) I underestimated the extent to which these areas would be covered on the exam and found myself struggling on these questions."

Thomas also observed that his specific career path had not exposed him to all possible applications that could be formulated into test questions from BoK resources. Of course, not all machinery is used across all industries, but two hours into an MLE exam is an inconvenient time to realize this.

"I underestimated the lubricant selection and application for all types of machinery, some of which I have not yet been exposed to in my career, such as turbomachinery or certain types of compressors," Thomas commented. "So, trying to identify an optimal lubricant for these applications was difficult for me and something I was unprepared for."

Similarly, Gabriel Delgado, senior technical instructor at Freeport McMoran, found the scope of the exam met his expectations and was up to date. However, specific questions still posed a challenge. Like the others, Delgado ran into unforeseen emphases.

"I did not anticipate the knowledge base of refining used lubricants, oil reclamation," he said. "I also had an excessive amount of questions on seal designs I did not anticipate."

Cameco's Brad Owen had a similar run-in with the unexpected.

"With my other ICML and maintenance professional certifications, I felt comfortable that I would be able to pass the exam," he stated. "(But) there were a few questions on statistical analysis that I was not prepared for."

Gaps in the Test?

On the opposite end of the spectrum, a couple of respondents suggested that some BoK topics were somewhat underrepresented. For instance, OilDoc's Rüdiger Krethe assumed the exam would have included more about lubricants and lubrication in the MLA and MLT overlapping content. Wojciech Majka, president and CEO of Ecol and Ecol North America, expressed similar concerns.
"I thought more tribology/lubrication engineering issues would appear," he noted. "That was a wrong assumption."

In all fairness, there are 24 areas in the comprehensive BOK and only 150 questions on the exam, so some areas receive less attention than others. Because the MLE is not explicitly a continuation of the MLA or MLT tracks, the overlap of those other bodies of knowledge is not meant to be robust.

Echoing this sentiment in a broader sense was ICML technical contributor Mike Johnson, who assumed there would be a more obvious correlation between the exam's BoK and the certification's name.

"The certification is titled, 'Machinery Lubrication Engineer,' (but) a substantial amount of content with this certification is about maintenance group/program management, not lubrication engineering," Johnson pointed out.

ICML does, in fact, promote the MLE as a management-level certification, which is consistent with Johnson's assessment. His fear is that candidates might alter their study plans based on the title alone. (ICML recommends candidates review all 24 BoK areas and assume nothing as they prepare.)

Trick Questions?

Just like the questions on all other ICML certification exams, MLE exam questions are in the multiple-choice format. However, both Majka and WestRock's Jeffrey DesArmo expressed concern over questions that pose multiple possible solutions. One of them used the phrase, "more than one correct answer," and the other labeled these questions as "tricky."

While a question technically cannot have more than one correct answer, it may present a scenario where the test-taker can discern multiple realistic solutions among the available choices. Any such question instructs the candidate to identify a "best" solution. In this way, there is still only one correct answer for scoring purposes. Of course, if a question is irredeemably vague, ICML would want to know about it to consider revising it.

As Optimain's Danny Shorten learned, none of these questions is ever intended to be a so-called trick question.

"Knowing how other lube analysis certification tests work, I was concerned that the multiple-choice questions might be structured to catch me out, which I found they did not," Shorten said.

In real life, every lubrication scenario may present multiple options involving many variables, parameters and business priorities that must be considered to identify an optimum solution. It only makes sense that the MLE test questions reflect such realities.

Other Concerns

ICML allows up to four hours to take the MLE exam, while the organization's other certification exam sessions end at three hours. Because candidates for different certifications may share the same exam room, ICML currently mandates a short break at three hours to release the MLA, MLT or Laboratory Lubricant Analyst (LLA) test-takers before any remaining MLE candidates can proceed with their exams for an additional hour. This arrangement necessitates splitting the MLE exam into two parts: Part 1, which is roughly 110 questions, is turned in at the end of three hours, while Part 2, which is approximately 40 questions, is turned in at the end of the fourth hour.

Only DesArmo mentioned this break in his response, suggesting that its configuration may require ICML's further attention.

"I was concerned about the allotted time split, and it did have an effect on the exam," he explained. "(There was) too much time on the first part and not enough on the second."

With this in mind, MLE candidates should be prepared to pace themselves accordingly.

Finally, Majka expressed concern for candidates whose native language is not English, worrying that they would experience difficulties until such time as the MLE is translated into more regional languages. (As of this printing, the MLE exam is available only in English and Spanish.)

"Language makes it more difficult for non-native speakers," Majka added. ***ML***

Kurt Rommelfaenger | Oil-Rite Corp.

Circulating Oil Systems: **What You Should Know**

"There is not one size that fits all when it comes to circulating oil systems."

Circulating oil systems or lube skids provide continuous flow of lubricant to bearings, gearboxes and blowers. They lubricate machinery used to pump stormwater, circulate fresh air into mines, extract oil, power ships, manufacture paper and chemicals, and test military equipment. In some cases, the bearing manufacturer supplies the lube skid as part of a single-source solution. In other instances, a bearing already in service may be overheating or exhibiting wear and is in need of a more dynamic lube system. In either case, the responsibility for speccing the oil system lies with the party having firsthand knowledge about the bearing. The circulating oil system may be less familiar territory.

There are three approaches to procuring a circulating oil system. The first is to construct it with in-house resources. This is both a science and an art. There are many skilled maintenance individuals who can make the connections, assemble the piping and get all the controls to work together. Be prepared to spend time researching components and suppliers. If working without a drawing, you can expect on-the-spot engineering and re-engineering (i.e., fixing mistakes and miscalculations).

Figure 1. An example of a circulating oil system.

The second approach is to purchase a prefabricated unit. Some manufacturers of circulating oil systems have off-the-shelf units. They may be completely assembled or can be quickly constructed from on-hand components. The shortened lead time can be helpful when dealing with a bearing that is overheating in summer temperatures. There will be limited options to choose from, which could result in an underequipped system or an oversized, less efficient system.

The third approach is to design a system with a specialized manufacturer. There are inherent benefits to experience and planning. A good manufacturer will offer drafting/engineering resources, have reliable suppliers and be an expert troubleshooter. Circulating oil systems often provide decades of service, so it is best to design them to have adequate controls, convenient maintenance and efficient power usage.

No matter which approach is employed, forethought should be given to what the system needs to do and how an array of different parts must come together to accomplish it.

The Essential Function: Oil Flow

The essential function of a circulating system is to deliver the prescribed flow of oil into the bearing. The oil is collected from the bearing, as suggested by the name "circulating oil system." The oil is filtered and cooled (if necessary) while passing through the lubrication system. The path the oil follows is shown in Figure 2. It begins with the oil coming into the reservoir through piping connected to an overflow port at the bearing. The bearing is located at a higher elevation than the system, so the oil flows by gravity. Fluid spills over the baffle in the reservoir. Larger contaminants tend to settle on the side of the baffle where the oil enters. The suction created by the pump draws the fluid into the piping. A strainer traps large particles before the oil enters the pump. The motor drives the pump to create flow and pressure. Next, the oil is routed through a filter to remove fine particles so they do not reach the bearing. The oil then flows to the bearing. Finally, excess fluid is directed back into the reservoir through a bypass valve.

In its simplest form, a circulating oil system may not require any type of control other than its power supply. The system forms a loop and functions without interruption until a filter replacement is necessary. The features inherent to a circulating oil system are shown in Figure 3.

Determining System Requirements

Each application of a circulating system is unique. The bearing manufacturer should be consulted for the specific flow rate, system pressure, fluid type and operating temperature. The user specifies the connecting piping size, line distances, elevation to the bearing, surrounding temperature, power availability and safety considerations.

Instruments and electronic controls can be added to cope with demanding environments or provide active feedback to the operator. For instance, warnings and fail-safes can ensure that any variances are detected and action is taken before the lubrication of the bearing is compromised. Such precautions may be warranted if the bearing is started and stopped as part of its normal operation, the load or rotation speed varies, the temperature fluctuates, or it is in a particularly dirty environment.

Some bearings must operate without interruption, which requires that the circulating oil system do the same. Redundancy can be built into the system. Dual filters with separate piping and control valves enable the filter to be changed while the flow of oil is diverted. A built-in second pump and motor can serve as a backup so the system remains operational during service or major component replacement.

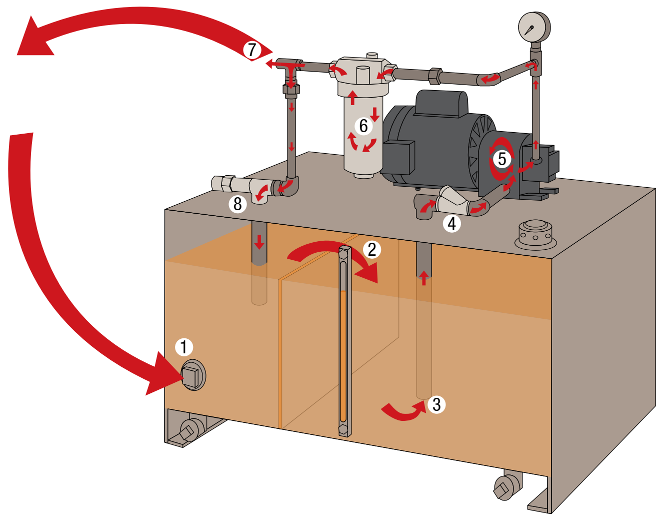


Figure 2. Oil flow through a circulating system.

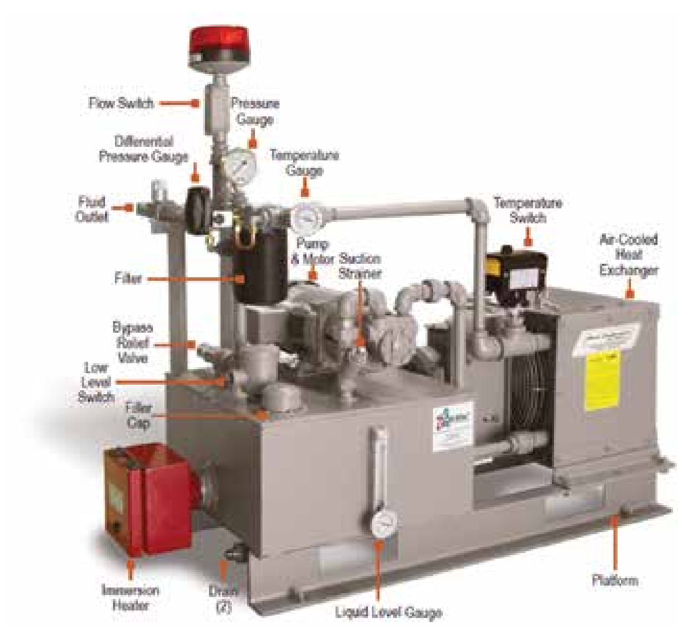


Figure 3. Circulating system components.

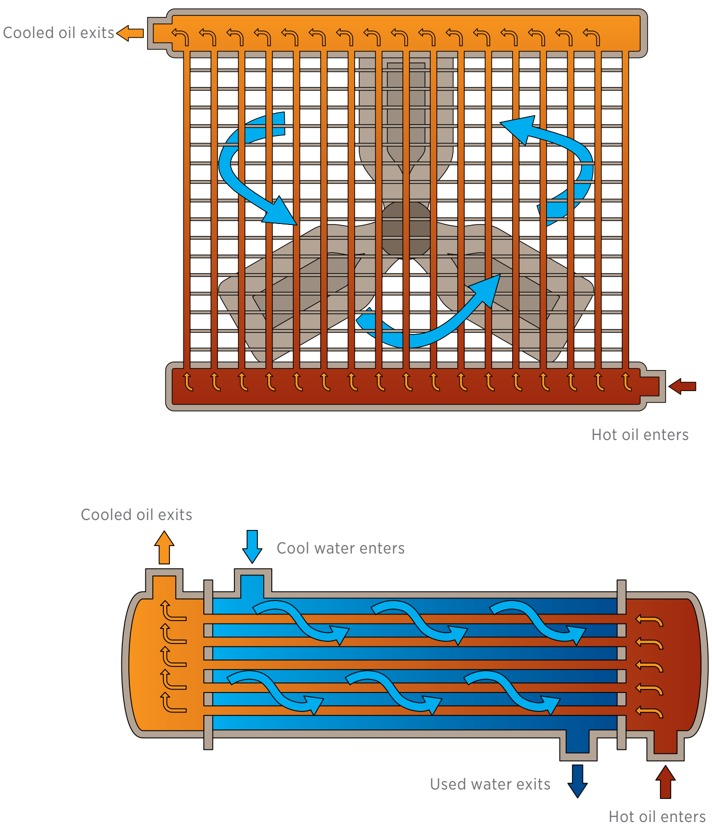


Figure 4. Examples of an air-cooled heat exchanger (top) and a water-cooled heat exchanger (bottom)

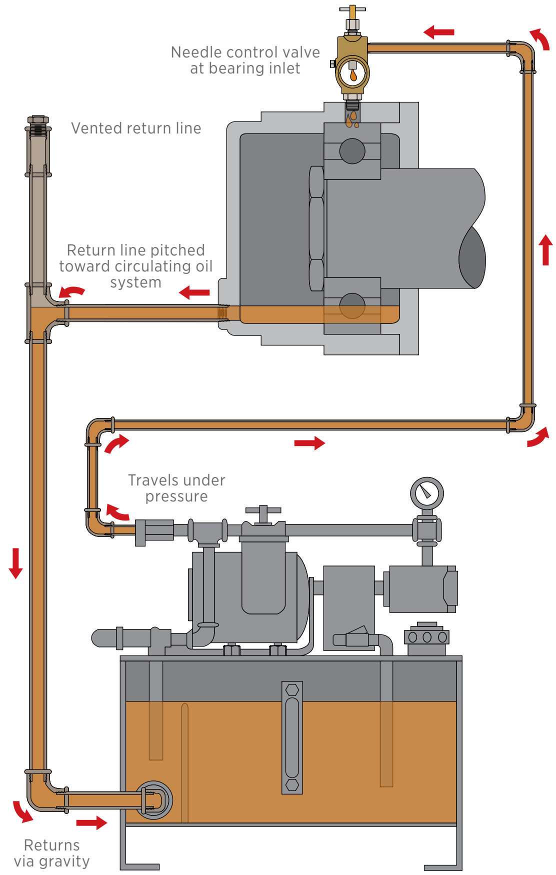


Figure 5. Elevation and venting of a circulating oil system

Matching Components to the Requirements

Consider the following factors when specifying a circulating oil system:

Flow Rate

If the system is supplying more than one bearing, the flow rate must equal the sum of the requirements. Flow into the bearing is controlled through the use of a needle valve at the delivery point. The pump and motor are sized to the maximum required flow rate plus a small contingency factor. The pump supplies oil at a constant rate. Any flow in excess of what the bearing can accept is diverted back into the lube skid's reservoir by a bypass relief valve located near the fluid outlet.

Pressure

A typical operating pressure is 35 pounds per square inch (psi) or less. Specialized applications may require higher pressures, such as a system designed to suspend a bearing in lubricant during startup to avoid metal-to-metal contact. The maximum amount of pressure is determined primarily by the pump's capability. Adjusting the bypass relief valve so less oil passes through to the bearing will increase system pressure.

Pumps and Motors

Motors are available in different voltages, frequencies and phases to best suit the available power sources. The typical motor is rated as TEFC (totally enclosed, fan cooled) and is suitable for many industrial environments. A system located in an area with combustible vapors and dust may need to be rated as explosion proof. The class, division and group must be identified for an explosion-proof motor.

Filtration

A circulating oil system typically uses three methods of filtration. The reservoir is equipped with a baffle that partially separates the two sides. The fluid comes into the reservoir on one side of the baffle where sediment tends to settle. The oil passing over the top of the baffle benefits from this initial phase of passive filtration. As the fluid is drawn out of the reservoir, a second level of filtration is achieved when it passes through a mesh strainer. Final filtration occurs prior to the fluid exiting the system, usually with something like a 23-micron filter. It is advisable to clean the strainer and change the filter on a regular maintenance schedule.

Gauges

The gauges on a circulating oil system offer a means of monitoring the operating conditions. A pressure gauge between the pump and bypass relief valve is used to verify that the pump is operating as intended and that the bypass relief valve is preventing excessive pressure buildup. The temperature of the fluid in the tank is visible using a thermometer built into the liquid-level gauge.

A temperature gauge installed in the piping gives feedback on the temperature of the fluid after passing through a heat exchanger. A differential pressure gauge is used to measure the amount of pressure lost while passing through the filter. Loss of pressure indicates the filter may need replacing.

Switches

Signals obtained from switches can be interpreted by electronic controls to send information to monitoring stations, manage how the unit functions, activate alarms or shut down equipment.

A temperature switch provides the ability to signal a high temperature or activate the heat exchanger. A liquid-level switch can indicate that the oil level in the tank is low because of system loss or because fluid is not returning fast enough from the bearing. A liquid-level switch can also be used to signal when the tank level is high due to an unexpected restriction of flow in the piping or at the bearing.

A low-flow switch activates when flow drops below a desired level. This condition can be caused by a clogged filter, pump malfunction, power interruption or depleted fluid. The signal from the switch can give valuable warning time to take corrective measures.

A differential pressure switch signals that the pressure is elevated after passing through the filter. This indicates the filter needs to be replaced.

Heat Exchangers

The purpose of a heat exchanger is to reduce the temperature of the oil before returning it to the bearing. Heat exchangers transfer heat from the fluid to either the air or to water (Figure 4). An air-cooled heat exchanger uses a fan to blow air over the oil as it passes through a series of smaller tubes. The tubing for a water-cooled heat exchanger is routed through a cylinder that has a continuous supply of water passing through it.

The heat exchanger is sized to the number of British thermal units (BTUs) required to be removed per hour. This is calculated using the temperature of the oil as it exits the bearing and the temperature required when returning to the bearing. The heat exchanger size is dependent on the air or water available for cooling. An air-cooled heat exchanger cannot reduce the oil temperature to less than the surrounding air temperature. Warmer ambient temperatures will create the need for a larger heat exchanger. A water-cooled heat exchanger offers increased efficiency with a lower water temperature and a higher flow rate of water.

Heat exchangers can be manually operated by an attendant or controlled automatically using a temperature switch or readings from a temperature gauge. They can also be wired to operate continuously.

Immersion Heaters

An immersion heater works in contact with the oil in the system reservoir. It raises the temperature of the fluid. A typical use would be to start up the system in cold climates. The oil is heated to reach its optimal viscosity before circulating to the bearing. The heater uses a built-in thermostat to shut off when the predetermined temperature is achieved.

Installation Environment

The operation of a circulating oil system can be affected by its surroundings. Temperature, altitude and exposure to the elements should be taken into consideration in the design. The space available for the unit affects the proportions of the tank, the mounted position of the components and the piping configuration.

The bearing should be at an elevation higher than the circulating oil system so oil can return to the system by gravity (Figure 5). The return line must be vented and two sizes larger than the supply line to avoid backup. The pressure required to supply oil to the bearing can be affected by the elevation to the bearing, reductions in pipe size and any restrictions caused by manifolds or nozzles.

Reservoirs and Piping

A standard reservoir is welded steel. The cover is a heavy-gauge steel. It is used as a platform for mounting system components. The piping and fittings usually are made of iron with national pipe thread (NPT) fittings. The entire system requires painting or some type of protective coating to avoid corrosion.

Reservoirs and piping can also be stainless steel. The connections may be welded, and some fittings are flanged. Circulating oil systems should be tested for leak detection and component operation before being put into service.

Getting What You Ask For

There is not one size that fits all when it comes to circulating oil systems. Work closely with the bearing manufacturer to determine optimal operating conditions. Tell your lube skid builder what you need the system to do. Factor into the design the fail-safes, maintenance and durability that suit your application. The system will be as good as the forethought put into it. *ML*

TEST YOUR KNOWLEDGE

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

1. Polyolester synthetic lubricants are considered members of what API Group?

A) I
B) II
C) III
D) IV
E) V

2. Live-zone sampling a circulating oil system means:

A) Always using a live sample pump to take the sample
B) Taking a sample from a static (non-flowing) straight piece of pipe in laminar flow
C) Taking a representative sample from a flow line that contains flowing oil
D) Taking a sample hot
E) Taking a sample from a zone in the system that contains the most wear debris

3. The proper time to drain the oil from a gearbox is:

B) At the end of the day
C) At the beginning of the following shift
D) While it is still hot from operation
E) After it has cooled and the particles and water have settled near the bottom

ANSWERS

1. E

Polyolester synthetic lubricants are considered to be members of API Group V. Polyolesters have excellent low-temperature properties, good lubricating properties and low volatilities.

2. C

Live-zone sampling means avoiding stagnant oil in any dead leg within the system. However, it is important to ensure that the flow in the live sampling zone is highly turbulent. Elbows and sharp bends are good examples of high turbulence areas. Sampling from a laminar flow area (straight line) results in a substantial reduction in particle concentration entering the sample bottle because of particle fly-by.

3. D

Oil will be less viscous at high temperatures, which can help to drain the maximum amount of oil. In addition, oil at high temperatures has better solubility, so it can hold more contaminants and degradation byproducts that need to be removed with the oil change.

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

Slight Changes Can Mean Big Problems

Copper readings can be particularly alarming when increases are in the hundreds of parts per million. However, huge increases are typically insignificant in terms of component wear. Ironically, small subtle increases in copper are of greater concern and should be examined closely. Copper alloy component wear is generally accompanied by lock-step increases in alloy metals such as lead, tin, aluminum and zinc. The amount of alloy metal present in brass/bronze components is only a small percentage of the total copper content. Changes in these alloys may be only a few parts per million but should be taken seriously when present with copper increases.

Advice for Coupling Grease Application

When changing the lubricating grease in a geared motor coupling, always apply a full coating of grease to the teeth of the coupling. Never fill the coupling housing completely with a grease gun due to expansion of the grease as the motor comes up to running temperature.

This expansion of the grease will apply internal coupling pressure, pushing the motor shaft off magnetic center and onto the thrust surface of your bearing, causing bearings to overheat and leading to early bearing failure.

Even after hand-packing the coupling, the motor should be run up to operating temperature, then shut down and the grease plug removed to allow excess grease and pressure to be released.

Handy' Sampling Tip

During regular weekly or monthly oil sampling, use a tube of "handy wipes" to keep your hands cleaner while handling sample equipment. This practice may not show directly in the cleanliness of the samples, but it feels cleaner, looks very professional and sends a message about the importance of contamination control.

Greasing Gearbox Bearings

Does your gearbox have a sealed or open input shaft bearing? This bearing is often above the gearbox oil level and must be greased if it is an open bearing. Manufacturers may ship the gearbox with a plug where the grease fitting is needed to prevent damage during shipping.

In addition, the manufacturer may change the input shaft bearing design from open to sealed and back to open without notification. Small changes such as no longer receiving an attached plastic bag with a grease fitting included with the replacement gearbox may be a clue to a change in design. Always check the manual included with the new gearbox to see if the lubrication needs have changed. *ML*

Did You Know?

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

Have Some Tips?

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

Jhumpa Mukherjee | VAS Tribology Solutions

Lubricant Packaging: **New and Upgraded Systems**

Packaging Industry is turning out to be one of the dominant sectors in India. Rapid changes are taking place in efficient packaging systems development globally. Lubricant packaging includes all kind of packaging which are used in handling, storage and transportation of lubricants. Lubricants are used in almost all major heavy-duty industries including oil & gas, metal fabrication, power generation, automobile, etc. The packaging depends on the type of product and the industry it serves.

Lubricant packaging companies are focusing on mounting their business through mergers and acquisitions. More than 600 types of packaging machines and equipment are manufactured by small and medium-sized enterprises (SMEs). This emerging opportunity for the packaging industry is giving rise to new visions and prospects.

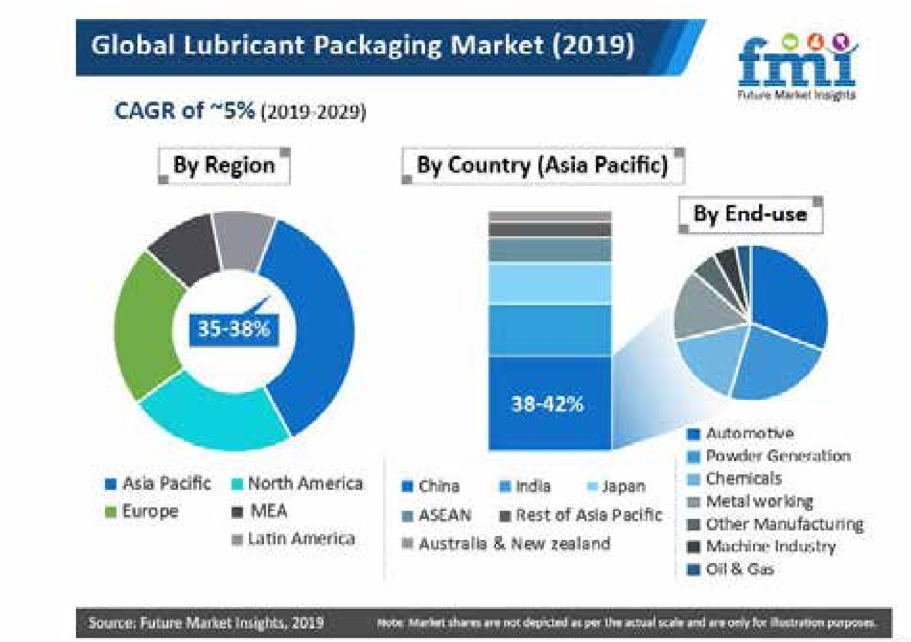
Key Points

- The global lubricant packaging market size was ~US$ 9 billion in 2018. The lubricant packaging market is expected to grow at a compound annual growth rate (CAGR) of ~5% during the period of 2019-2029.
- The lubricant packaging in automotive industry is expected to account for fairly high sales.
- Collectively, Asia Pacific and Europe are predicted to account for ~60% revenue share in the lubricant packaging market, by the end of 2029.
- Middle East & Africa and other developing countries will continue to hold a high potential for the growth of the lubricant packaging market. Increase in trade between developed and developing economies for industrial oil and other fluids are probable to drive the lubricant packaging market growth.

Global Lubricant Packaging Market: Regional Analysis

The lubricant packaging market is highly competitive. The players in this market have multinational presence with an extensive distribution network. Some of the market contenders include Glenroy, Inc., Scholle IPN, Duplas Al Sharq LLC, Mold Tek Packaging Ltd, CYL Corporation Berhadcompany and Balmer Lawrie & Co. Ltd. Expansion and merger strategies

Market Segmentation		
By Packaging	**By Lubricant**	**By End-user**
• Pails • Kegs & Drums • Cans & Bottles • Stand-up Pouches • Tubes • Bags-in-box • Others	• Engine Oils • Metalworking Fluids • Process Oils • Transmission & Hydraulic Fluids • General Industrial Oil • Gear Oil • Others	• Power Generation • Metal Fabrication • Chemical • Automobile • Others



are adopted by key players to grow their business and product portfolio. Product developments and new product launches are also among the important trends followed by prominent lubricant packaging manufacturers.

During the past, Asia Pacific led the overall lubricant packaging market size, in terms of value and volume. It is poised to witness tremendous growth during the forecast period (2019-2029) due to steadily increasing demand from mining, machining, metal forming and plastics industry mainly in India and China. Asia Pacific will continue to be the highly lucrative region for lubricant packaging market throughout the forecast period as per the report published on futuremarketinsights.com. Online retailing of consumer lubricants is another evolving trend which is most visible in China with established portals like JD.com and Alibaba. Continuously progressing and growing automobile industry with rapid technological changes in North America will also have a positive influence on the regional lubricant packaging market.

Pitfalls and Challenges

The companies in packaging industry are facing numerous challenges of handling customer preferences, sales competition, fluctuating prices of feedstock used for packaging products manufacturing and product quality endurance. Environmental safety concerns have impacted the growth of the plastic-based packaging materials market and there was a significant blow to the industry due to the government regulations and policies in favor of ecological issues.

However, the ever-changing aspects of the industry, introduction of eco-friendly packaging products and innovation has uplifted the industry and today the Indian market is competing to the global standards. Lubricant packaging manufacturers are shifting towards flexible packaging format, due to its affordability and convenience. Stand-up pouches and bag-in-box are gaining more attention because these are lighter than rigid plastic bottles and consume 60 percent less plastic.

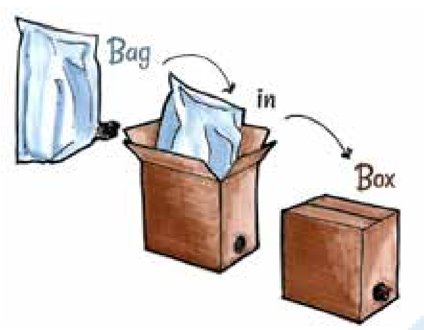
Trends in Automotive and Industrial Lubricant Packaging

1) Shell introduced color-coded bottles for Aeroshell Piston Engine Oils which made it easier to recognize and choose the product with confidence. The benefits of new packing are as follows:
   - New bottle design – Color-coded by product benefits for easy recognition.
   - New back label design – Consumer friendly back label, new multi-page pull-out covering up to 14 languages.
   - New cartons and case configuration.

Shell also introduced Ecobox; motor oil container that reduces plastic waste. Using the Ecobox plastic liner results in 89 percent less plastic landfill waste and the carton is fully recyclable.

2) Back in 2012, Wichita-based Universal Lubricants—now a subsidiary of PetroChoice—was thought to be the first United States company to introduce retail motor oil in a pouch. Universal Lubricants manufactures the ECO ULTRA oil pouches using a 6-mil, 3-layer barrier construction of polyester, nylon, and linear low-density polyethylene (LLDPE). Which are-
   - Lighter in weight enabling freight cost reductions.

- Unfilled flex-packs are equivalent to 26 truckloads of unfilled rigid plastic containers.
- Translating into a significant reduction in fuel consumption, road emissions, fleet maintenance, and operation costs.



Sample picture (Source - netpak.com)

Another relatively new concept is the bag-in-a-box, a single-use cardboard container that houses a plastic bag filled with product. Recognized for being easy to stack, store and ship, these uses far less material than the equivalent-sized rigid plastic bottles, significantly helping to reduce landfill waste. Universal's bag-in-a-box package is a simple idea with big benefits.

3) Valvoline introduced a new stand-up pouch for two varieties of its synthetic gear oil. Valvoline worked with Hammer Packaging to design the FlexFill bag, which is a lamination of PET/nylon/low-density polyethylene, with the layers chosen for printability, strength and sealability, respectively. This FlexFill bag made changing of synthetic gear oil easier and also providing a more flexible, less wasteful automotive DIY (Do-It-Yourself) experience.

4) SK Lubricants manufactured eco-friendly containers from recycled waste plastics by conducting research with SK Innovation's Chemical Research Center and SK Global Chemical, an affiliate of SK Innovation's chemical business. This packaging manufacturing technology has been certified by UL, a global safety certification organization. The eco-friendly container was applied to all engine oil products under the SK ZIC ZERO and SK ZIC World Series brand. Additionally, the aluminum stopper and the label attached were all unified with polyethylene (PE), the same plastic material. If the material is fused in this way, it becomes easier to separate and dispose the lubricant package after the product is consumed.

5) Fuchs Lubricants first introduced its Lube Cube in 2012 to tackle the growing environmental concerns. The packaging system was shortlisted as a finalist in the 'Supply Chain Solution of the Year' category for the United Kingdom Packaging Awards.

The Lube Cube is fully recyclable and can be included with the normal recycling waste, resulting in significant savings with its disposal. The 20-liter version uses 79% less plastic than a conventional plastic container and cuts disposal costs upto 96%, says Fuchs. Since the launch of this packaging, the company has saved more than 78 metric tons (1.7 million pounds) of plastic, equivalent to 15.6 million plastic bottles or 93.6 million plastic carrier bags.

Now-a-days, it's not just about storing products; it's about increasing productivity and efficiency as well as reducing cost and harmful impact on environment. Modern packaging is about keeping these points into consideration. A design is ultimately judged on its usefulness and purpose. Yet with different portfolios and lubricants more specialized, there is a growing focus on creating containers that offer much more.

Consumers and end users have become more conscious about the importance of clean environment and greener solutions. A packaging should be easier to clean, recycle and reuse. Studies say that users are ready to pay a premium for more environmentally friendly options. There is a saying that best things come in small packages, and with the growing demand of flexible packaging in recent times, it appears to be true and believed by the end-users. ***MLI***

SKF India launches new automotive aftermarket products

SKF India's automotive aftermarket division has launched three new products to address customer needs for improved durability and performance. They are sprockets for 2-wheelers, timing belts, and steering and suspension systems for 4-wheelers. These innovative products are of high quality, and superior strength and durability, the company said in a release recently.

Picture courtesy- auto.economictimes.indiatimes.com

S Venkat Subramaniam, Director - automotive business, SKF India, said, "These new automotive aftermarket products demonstrate our dedication to understanding and fulfilling the needs of our customers. Designed to support the enhanced performance needs, these new products come with world class quality, which SKF is known for and aims to deliver great reliability and durability to vehicle owners of both the two and four-wheeler category. We believe that customer satisfaction is paramount and have been working on introducing new product lines that deliver the correct balance of performance and value to customers".

Indian Oil Corporation collaborates with Israeli company Phinergy

Indian Oil Corporation (IOC) recently entered into collaboration with Phinergy, an Israeli start-up company specialising in hybrid lithium-ion and aluminium-air/zinc-air battery systems, to form IOC Phinergy Private Limited.

According to a press release, the collaboration took place in the presence of Union Minister Dharmendra Pradhan and Israel Energy Minister Yuval Steinitz.

The joint venture will manufacture Aluminum-Air systems in India to boost India's flagship programme - "Make in India" and recycle used Aluminum to strengthen India's energy security. In a significant boost to India's pursuit of e-mobility, two of the leading automotive manufacturers in India- Maruti Suzuki and Ashok Leyland signed a Letter of Intent (LOI) with the newly incorporated Joint Venture IOC Phinergy Limited, said the release.

Picture courtesy- orissadiary.com

BASE OIL REPORT

OPEC and a group of 23 major oil-producing countries that had cut crude oil production levels during the peak of the Covid-19 pandemic, the price of Brent crude fell to below $20 per barrel, have decided to maintain lower production levels through April. A consistent rise in crude oil prices has contributed to auto fuel prices reaching record highs in India as it import over 80 per cent of its crude oil requirements.

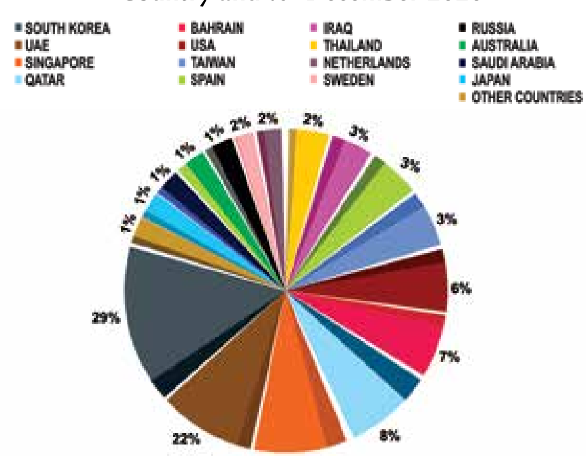
The Indian domestic market Korean origin Group II plus N-60–70/150/500 prices at the current level are marginally up for lighter grades and heavier grades. Domestic importers and traders prices for N – 70/ N- 150/ N - 500 grades and at the current level are quoted in the range of Rupees 62.80 – 63.00/63.00-63.15/75.00 – 75.20 per liter in bulk plus 18% GST as applicable. Discounts are being offered for sizeable quantity. The above mentioned prices are offered by a manufacturer who also offers the grades in the domestic market, while another importer trader offers the grades cheaper by Rupees 0.30 – 0.35 per liter on basic prices. Light Liquid Paraffin (IP) is priced at Rupees 64.35 – 64.50 per liter in bulk and Heavy Liquid paraffin (IP) is Rupees 81.45 – 81.60 per liter in bulk respectively plus GST as applicable.

In the month of December 2020, India imported 452372 MT of Base Oil, India imported the huge quantum in small shipments on different ports like 202502 MT (45%) into Mumbai, 71855 MT (16%) into Hazira, 59981 MT (13%) into JNPT, 34300 MT (8%) into Mundra, 27874 MT (6%) into Kandla, 22929 MT (5%) into Chennai, 19173 MT (4%) into Pipavav, 8264 MT (2%) into Kolkata, 2629 MT (1%) into Delhi and 2867 MT (1%) into Other Ports.

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

Month wise import of Base Oil in India

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



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

Month	N- 500 Korea Origin Base Oil CFR India Prices	SN-150 Iran Origin Base Oil CFR India Prices	N - 70 Korea Origin Base Oil CFR India Prices	RPO Drums (Aromatic Extract) CFR India Prices
January 2021	USD 725 – 760 PMT	USD 645 – 660 PMT	USD 655 – 675 PMT	USD 345 – 365 PMT
February 2020	USD 760 – 795 PMT	USD 675 – 685 PMT	USD 680 - 690 PMT	USD 375 – 385 PMT
March 2021	USD 860 – 860 PMT	USD 760 – 790 PMT	USD 755 - 780 PMT	USD 395 – 405 PMT
	Since January 2021, prices have increased by USD 105 PMT (14%) in March 2021.	Since January 2021, prices hiked up by USD 125 PMT (19%) in March 2021.	Since January 2021, prices have increased by USD 105 PMT (16%) in March 2021.	Since January 2021, prices have gone up by USD 45 PMT (13%) in March 2021.

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3. Quality control and importance of testing components and products for each blend.
4. Product compatibilities & techniques to avoid or minimize problems with lubricant blending and product quality.
5. QA aspects in lubricant product filling, packaging and warehousing.

Who should attend ?

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2. Blending plant managers and operators
3. Entrepreneurs manufacturing lubricants
4. Lubricant specialists
5.quality assurance professionals
6. Blending equipment and packaging manufacturers

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Spanning four days, Reliable Plant 2021 includes workshops, learning sessions and case studies designed to upgrade the skills and knowledge of attendees. The conference will also feature approximately 130 exhibitors in a more than 200,000-square-foot exhibit hall inside the Kentucky International Convention Center.

For more information visit **Conference.ReliablePlant.com.**

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