Machinery Lubrication

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101 Ways to Improve Your Lubrication Program


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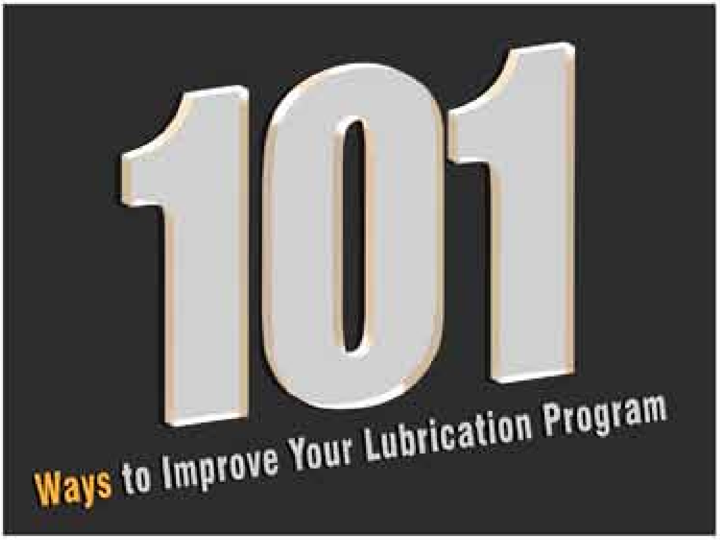
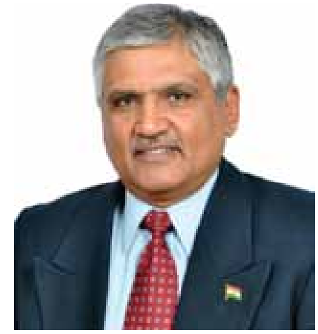


EDITORIAL FEATURES

Publisher's Note



It is often said that while the bearing is the heart of your (rotating) equipment, the lubricant is considered to be the blood. The health of your blood is as life threatening as the quality of the lubricant, whether they are oils or greases. Bad lubricant quality is extremely harmful for the health of machine components. Lubricant quality in the Lubrication Reliability Programme is a matter of managing the selected lubricants in the best possible way bearing in mind the 6 Lubrication Rights- the Right Type, the Right Time, the Right Quantity, the Right Place, the Right Way, and the Right Condition.

It has been proven many times by independent organizations that poor lubrication practices are responsible for over 43 percent of bearing and machine failures. Here asset managers have sinned against one or more of the 6 Lubrication Rights.

Lubrication Reliability (LR) is a combination of managing best practices, tools and strategies. To start a new LR strategy (or just implement one or more of its components) it is crucial to assess the actual lubrication management situation. Evaluation and benchmarking will disclose actual flaws in the implementation and stress out the weak points in the fields of: strategies, cleanliness & contamination control, lube supply, expertise and others. No maintenance organisation today should manage its activities without proper assessment. Lubrication is a very specialized field of maintenance and thus dedicated Lubrication Management is required to be implemented.

Sometimes even small quantity of cross-contamination can result in catastrophic failure. It does not take huge investments to well identify or colour-code lubricants, dispensing equipment and lube points on machinery to avoid malicious cross-contamination. While identification is imperative, lubricant inspection should be a continuous worry. It happens every day that machine components like gearboxes run dry of oil or grease. Oil Levels are overseen, are too dirty to inspect, or are not even included in the technician's inspection route.

New oils commonly have a higher contamination level than recommended by the machine supplier. Cleanliness control of new and stored lubricants should be the focus. As it is a basic issue, with small investments but huge return. It's all about improving the quality of new lubricants and protecting these lubes from environmental contamination like moisture, dirt, chemicals and so on. Today many innovative solutions are available to properly store and condition lubes: the best have dedicated tanks with pumps and filters for online filtering, proper identification and have protections like desiccant breathers. Systems that do not work in this way are just bad practice.

Oil Dispensing is an art. Oil cans need to have these basic requirements: fully sealed, translucent for inspection, colour-coded and identified and adapted to the application and fluids, preferably made of plastic to avoid rusting. Greases are difficult to clean up once contaminated. The use of cartridges or automatic lubrication systems is preferred.

No Lubrication Reliability programme should start with a group of people not having the right skills and training. Technicians, reliability engineers, foremen and managers will have to be educated at their level. Plenty of good training programmes are available out there as well.

We would like to thank our readers for the encouraging response to our previous edition's cover story – "The power of using multiple technologies for machine inspections" and other articles. Our current issue's cover story "101 ways to improve your lubrication program" will help our readers to find numerous ideas to develop a world-class lubrication program.

We welcome readers to participate by sending their feedback & contributing articles and case studies.

Warm regards,

Udey Dhir

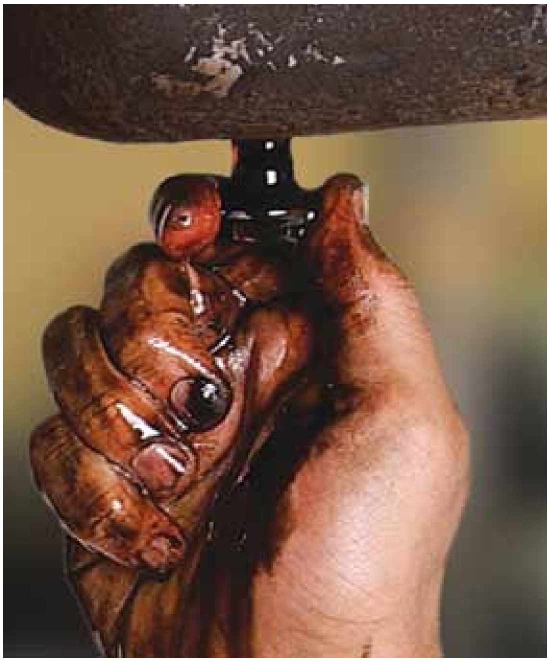
Managing the Perils of **Short-volume Oil Changes**

The term "short-volume oil change" (SVOC) relates primarily to circulating oil systems. An SVOC occurs when an oil change (either scheduled or condition-based) only involves draining and refilling the oil in the system tank or sump. All or some significant portion of the oil remaining in the oil lines, hoses, bearings, pumps, filters, actuators, valves, heat exchangers, etc., is not changed. In other words, it is a partial oil change.

From a practical standpoint, when oil is drained from machines, there is always some residual amount that, at minimum, occludes to interior surfaces and becomes trapped in low regions, quiescent zones, and other nooks and crannies. For example, after an oil drain, diesel engines typically retain approximately 15 percent of their previous oil. When the engine is refilled with new oil, you end up with an 85-to-15 new-oil-to-used-oil blend.

> "It takes less than 5 percent oxidized oil mixed with new oil to **reduce the oxidation stability of the new oil by more than 90 percent.**"

The main concern with this practice is the influence the used oil has on the health of the blended new oil charge. If the used oil was low in volume and relatively healthy, the performance and life expediency of the new oil blend can be acceptable. Conversely, if the used oil was contaminated and/or heavily degraded from extended use, the performance and life expectancy of the new oil blend can be sharply affected. For instance, it takes less than 5 percent oxidized oil mixed with new oil to reduce the oxidation stability of the new oil by more than 90 percent.



Why Perform a Short-volume Oil Change?

There are several good reasons to perform an SVOC. One is that it's simply less disruption to the system. This includes avoiding the risk of dry start conditions and associated accelerated wear when the machine is restarted due to delayed lubrication (dry start). These conditions are the result of the time required to refill the lines and components with oil, purging out air, etc. Of course, many large systems have auxiliary pumps that pre-lube the system. Other machines may not have this feature.

Furthermore, performing a complete system drain can disturb sludge, sediment and deposits. To read more about this, see my article on oil flushing tips to address the fishbowl effect at MachineryLubrication.com. Unless these solid impurities can be fully purged from the system, they can mobilize within the machine and cause new problems (e.g., motion impediment, restricted oil ways, etc.). Leaks may also occur suddenly in areas where there was no leakage. For more information on this condition, see my article on oil clotting and the adrenaline effect at MachineryLubrication.com.

Unlike an SVOC, where perhaps only 40 percent of the actual oil charge is drained (see Figure 1), a full-volume oil change (FVOC) can take much longer. Additionally, there is much more oil involved and higher associated costs. That said, the service life of an FVOC should be disproportionally longer than an SVOC. For example, the life of an FVOC may be three times longer than a 40-percent SVOC (40 percent new oil blended with 60 percent used oil), and this assumes the used oil is relatively healthy and contaminant free.

One way to define a lubricant's remaining useful life (RUL) in a machine is to identify the remaining useful life of the additive system. Most additives are sacrificial. In other words, they give up their life to save the oil and the machine. As such, if they don't die, they aren't effective. While they are working, they are depleting. Eventually, no reserve additives are left. Of course, you should change the oil long before this point.

For simplicity, let's assume the antioxidant concentration of new oil is 100. At the time of the SVOC, the used oil had an antioxidant level of 25. The 40-percent SVOC resulted in a blended antioxidant concentration of 55, or 55 percent RUL of the blended oil. This equates to just more than half of the new oil's designed service life.

Lurking Dangers

Perhaps the most serious hazard relates to current oxidation of the oil being drained. These oxides spread rapidly like food coloring in a pitcher of water. They typically consist of chemically reactive hydroperoxides and free radicals that can burn through antioxidants coming in with the new oil in short order.

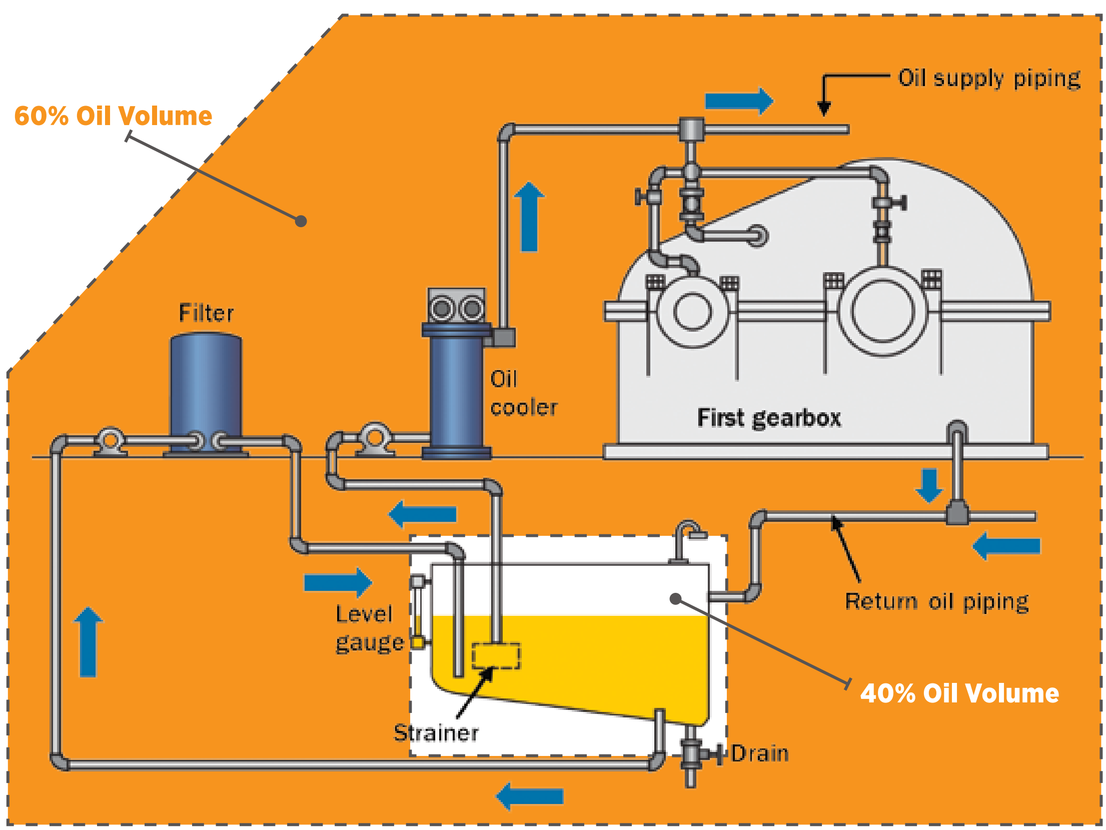


Figure 1. In many large-volume circulating oil systems, changing the tank oil alone results in nearly 40 percent of the full volume being drained and changed.

MACHINE OR SYSTEM	SVOC Percentage of remaining old oil after the tank is drained and refilled with new oil. This is machine dependent.	DOUBLE OIL CHANGE Approximate percentage of old oil remaining after draining and refilling the tank, followed by oil circulation. The drain-and-fill is then repeated.	SVOC FOLLOWED BY LINE PURGE Approximate percentage of old oil remaining after performing an SVOC, followed by diverting old line oil to waste.
A	60%	36%	12%
B	40%	16%	8%
C	30%	9%	6%
D	20%	4%	4%
E	10%	1%	2%
F	5%	0.25%	0.5%

Figure 2. The amount of used oil remaining in a system after performing an SVOC, a double oil change and an SVOC followed by a line purge (refer to the narrative on the following page)

You might think of these reactive chemicals as an infection. It's like sending nine healthy people into a room with a person ailing from a contagious disease. The good health of the nine doesn't cure the disease of the one. On the contrary, you end up with 10 very sick people. Any time a lubricant is oxidized (e.g., a viscosity increase, dark opaque color, elevated acid number, pungent odor, etc.), a complete system flush is required to purge the infection. Oil analysis can help schedule oil changes well in advance of base oil oxidation. Although less common, a similar problem occurs when a system is infected with microbial contamination (bacteria or fungi).

One of the advantages of an oil change is the opportunity to expunge ghost riders from your oil. Ghost riders are the microscopic hard particles that accumulate in oil over time. They are smaller than the pore size of the onboard oil filter. If you are using a 10-micron oil filter, particles smaller than 10 microns will circulate freely and unabated by filtration. The filter selectively removes only the particles larger than 10 microns. As new particles ingress during normal operation, the small ghost riders continue to grow in population until the oil is changed.

The problem with these ghost riders is that they can do many harmful things to machines. For instance, anywhere there is elastohydrodynamic lubrication (e.g., rolling-element bearings), these small particles can readily bridge the working clearance, damaging bearing surfaces in the load zone. Where boundary lubrication exists (starts, stops, slow-moving surfaces, misalignment, starved oil conditions, etc.), the ghost riders will cause the vast majority of the damage (three-body abrasion and surface fatigue).

44% of lubrication professionals perform short-volume or partial oil changes at their plant, based on a recent survey at MachineryLubrication.com

The following are additional benefits of an FVOC versus an SVOC:

Machine Devarnishing

New oil usually has a relatively high impurity-holding capacity (IHC) compared to used oil. This means when new oil enters a machine, some of the varnish and deposits from the previous oil can be cleaned away quickly. This devarnishing occurs when the oil has residual IHC aided by a higher operating temperature. Much of this can be lost due to an SVOC. To learn more about IHC, read the article titled "What is Your Oil's Impurity-holding Capacity (IHC)?" at MachineryLubrication.com.

Better Demulsibility

Most lubricants should demulsify water rapidly to mitigate damage to the oil and the machine. Solid and dissolved impurities of nearly all types build up in used oil and can inhibit demulsibility. These are passed on to the blended new and used oil after an SVOC.

Improved Air-handling Ability

For the same reasons an FVOC is beneficial for demulsibility, it is also good for a lubricant's efficient air release and low foam tendency/stability.

Longer Filter Life

The impact of soft contaminants (sludge, varnish insolubles, oxides, dead additives, etc.) on filter life can be substantial. Soft contaminants are the product of oil aging. As such, they are purged with FVOCs but less so with SVOCs.

Good Oil Analysis Baseline

Another disadvantage of an SVOC relates to oil analysis. Good oil analysis needs a reliable and consistent new oil baseline. Most oil analysis alarms are set as an offset to this baseline. If the baseline has been corrupted by blending new oil with old oil, so too is the effectiveness (precision) of the oil analysis data interpretation.

SVOC Alternatives

Fully purging a system of oil can be a difficult challenge. This is especially true with completely flooded lines and system components. The procedure may require partitioning the system, followed by breaking into lines in low zones to drain used oil and aided by air vents in higher zones. There are a couple of alternatives to consider based on the machine, the operating conditions and the need for an FVOC. These include the following (see also the table in Figure 2):

Bleed-and-Feed

This type of oil change normally can be performed on the run for stationary equipment without the loss of machine runtime. The process involves the progressive draining of tank oil and the addition of an equal amount of new oil, all while the oil remains circulating. For heavily degraded lube oil, it may take the equivalent of three or four oil changes (in new oil volume) to achieve the target level of oil quality and performance.

Double Oil Change

This will require a machine stoppage. The tank is drained and refilled in the same manner as with a normal SVOC. The oil is then brought back to operating temperature while circulating. Afterward, the oil tank is drained and refilled again.

SVOC Followed by a Line Purge

After the tank has been drained and refilled with new oil, the auxiliary pump is started and the new oil is pushed into the system. The old oil is not returned to the tank but rather diverted to waste until most of the old line oil has been discharged. The tank is then refilled to the correct level, and the return line is reconnected to the tank. Alternate procedures can achieve similar results depending on the machine/system involved.

Role of Oil Analysis

Oil analysis and Inspection 2.0 can substantially improve the outcome of SVOCs and mitigate the risks. This is largely the practice of carefully monitoring the aging health of the used oil and recognizing the sudden and escalating presence of a problem. Issues might include premature oil oxidation, the need for dehydration or portable filtration, rising varnish potential, the need for additive reconstruction and abnormal ghost rider concentration.

For large and critical systems, the timing of the oil change is key. The best way to ensure good timing is to allow the oil to talk to you through effective oil analysis and inspection. When done correctly, these methods will enable you to achieve optimum results. ***MLI***

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.

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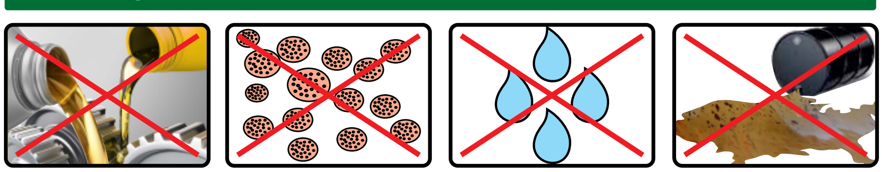

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OIL IN MACHINE IS LIKE BLOOD IN HUMAN BODY

101 Ways to Improve Your Lubrication Program

101 things you should know to develop a world-class lubrication program. Whether you are in the initial stages of implementing a new program or already have a well-established program in place, you should find numerous ideas that can help, with advice from each of the 101 issues.

1. Be Proactive

When applied correctly, a proactive maintenance strategy can double or triple lubricant service life. This is achieved by reducing the conditions that stress an oil (cleaner, cooler, drier, etc.).

2. Know Your Lubrication Needs

The next time you award a supply contract for lubrication, take the time to actually determine your company's needs. The process may reveal that you have been paying for services that you don't value or would prefer to buy elsewhere.

3. Skills Foster Reliability

If what you want most is to avoid machine failure, then what you need most are maintenance skills that foster intrinsic machine reliability.

4. Set Target Cleanliness Levels

The first step of a contamination control program is to identify a machine's target cleanliness level. A specific quantifiable number (ISO Code, for instance) should be assigned to each machine based on contaminant tolerance, operating environment and motivation for machine reliability.

5. Design Simple Lube Inspection Routes

Design lubrication inspection routes comprised almost entirely of questions that the inspector can answer "yes" or "no," or as "OK" or "not OK." This keeps the process fast and simple.

6. Replace Business as Usual

Achieving lasting excellence in machinery lubrication is neither difficult nor complex. It simply requires a clear sense of purpose and the tenacity to replace the old business as usual with a new one.

7. Consider Single-point Lubricators

Depending on the application, single-point lubricators can extend the life of rotating equipment and increase reliability while significantly reducing the cost of applying the lubricant.

8. Use Performance Metrics

If used properly, a performance metric works like a compass. It helps you find your bearings and get on the right track when performance is substandard. Once the organization is performing on target, metrics help to keep it on track and facilitate continuous improvement.

9. Follow the Root-cause Trail

Machines don't just die; they're murdered. If you follow the root-cause trail, you will likely find a smoking gun in the hands of one or more well-intentioned individuals (operator, craftsman, technician, mechanic, engineer, etc.) who simply didn't know any better.

10. Achieve a Cultural Transformation

No single product or training course will accomplish cultural transformation because people resist change by nature. A cultural transformation requires a clearly defined and cohesive plan that may take a considerable period of time to fully accomplish.

11. Requirements for a World-class Lube Program

The best lubrication programs, often referred to as world class, are those that have world-class lubrication technicians, use world-class lubricants and deploy world-class procedures.

12. Collaborate for Lubrication Excellence

Lubrication excellence is a collaborative process. By taking an active role in testing new lubricants and giving constructive feedback to your supplier, incremental improvements in lubricant quality are bound to result.

13. Don't Waste Your Money

Saving money by buying cheap oil is almost always a false economy. On the other extreme, buying quality oil to remedy bad lubrication is also a false economy.

14. Know the Dangers of Grease Incompatibility

Contemplating a switch of grease products brings to light the critical issue of compatibility. Before implementing a new product, plant and maintenance engineers must weigh all consequences of grease intermixing and the impact on equipment reliability, production levels and the bottom line.

15. Plan and Research for a Better Lube Room

A world-class lube room is not built overnight. The planning and research required are more time-consuming than the actual construction work.

16. The Importance of a Good Education

Training and education develop top-drawer lubrication skills and can give the dollop of grease and the rolling-element bearing a long, happy life.

17. How to Sell Your Project

It is incumbent upon the lubrication professional to translate a technically oriented program proposal into results that a manager understands and values. Whether you are selling your project to the executive suite or the maintenance managers, fit the message to the audience.

18. Ensure Fluid Cleanliness

Maintaining fluid cleanliness is a job that's never done. It involves a relentless cycle of sampling and remedial action as necessary to ensure the appropriate cleanliness level is continuously maintained.

19. Slow Down When Applying Grease

Do not rush the application of grease, as this can lead to oil bleeding in the feed line. Instead, apply using a constant force. Also, if the action is too fast, grease will leak at the labyrinth seals.

20. Detecting Bearing Distress

Through the prudent use of temperature and vibration monitoring equipment, routine oil analysis, lubrication system evaluations and machine operational performance reviews, bearing distress may be identified and evaluated before catastrophic failure occurs.

21. When to Outsource Lubrication

Under the right circumstances, when machinery lubrication is outsourced to create value and competitive advantage, not just to cut costs and/or window-dress the organization, it can be a winning strategy. It can help foster or perpetuate a "best-in-world" attitude.

22. Beware of Overheated Hydraulic Systems

Continuing to operate a hydraulic system when the fluid is over-temperature is similar to operating an internal combustion engine with high coolant temperature. Damage is guaranteed. Therefore, whenever a hydraulic system starts to overheat, shut it down, identify the cause and fix it.

23. Invest in Reliability

Improvements made to assure proper lubrication of your equipment will yield benefit regardless of its age. However, early, reliability-focused investments to build a lubrication program that works and to accessorize equipment for lubrication excellence will compound over time and maximize your returns.

24. Understand Wear Modes

It is estimated that 70 percent of machines are removed from service due to degradation of mechanical surfaces. Degradation may occur as a result of abrasive, adhesive, erosive, corrosive or fatigue-induced wear. A clear understanding of how these wear modes develop will assist the lubrication technician in understanding the importance of his/her role in improving machine reliability.

25. Make Oil Filters Last Longer

Oil filters last longer when they don't get plugged with particles. Therefore, the best strategy comes from working backward by tracing the particle ingression pathway.

26. The Key to Lubrication Program Success

While there are a number of excellent companies that offer outstanding products and services to support precision lubrication, it is the people — and more importantly their attitudes and the pervasive culture within the plant — which will do more to help the success or failure of the lubrication program than any other single factor.

27. Select the Right Lubricant

Selecting the proper lubricant is important to sharply reduce long-term costs. The best-fit product selection can mean longer lubricant life, reduced machine wear, reduced incipient power losses and improved safety.

28. Keep It Simple

Excellence in lubrication is a simple concept. It is about getting the right lubricant in the right place at the right time, making sure that lubricant is supplied in the right quantity and ensuring the lubricant is kept clean, dry and cool.

29. Follow Manufacturer Instructions

When relubricating electric motor bearings, always follow the motor manufacturer's specific instructions and do not use any lubricants other than those approved by the manufacturer.

30. Paying for Performance

Properly selected high-performance lubricants may create cost reductions many times greater than the price differential between the product types. Selecting a performance option should be based on the effect derived from a carefully engineered change, with the expected results calculated into commonly accepted financial terms.

31. Don't Blame the Lubricant

The universal panacea to a real or perceived lubrication failure is to blame the lubricant. Naively, we go looking for a better lubricant, when in actuality it may simply be how lubrication is performed that is at fault.

32. The Value of Oil Analysis

If used correctly, oil analysis can be a valuable predictive and proactive diagnostics tool. If used incorrectly, it can be a frustrating exercise in futility.

33. Match the Lubricant to the Application

Selecting lubricants for industrial gearing is similar in most applications. To identify the best choice for a given application, the right viscosity, base oil and type of lubricant must be selected and the appropriate performance properties evaluated.

34. Knowledge Is Power

When decisions are made to make improvements to your lubrication program, it is crucial that you decide what knowledge and to whom it must be disseminated to facilitate and ensure the quality of implementation and execution of these items.

35. The Importance of Proper Sampling

Without proper sampling methods, the value of oil analysis will be lost or severely diminished. The problem often lies in inconsistent and invalid data. Unless you can take consistent, repeatable samples, it is impossible to establish useful alarms levels.

36. Use Your Senses

An effective proactive/predictive maintenance program requires tools such as vibration, thermography and oil analysis to scan, inspect and determine the condition of machinery. However, your eyes, ears and nose can also be valuable condition monitoring tools and require little training to be utilized effectively.

37. Make Better Use of Filter Carts

Portable transfer/filter carts are versatile and can be used for more than just transferring fluids. Other possible uses include offline filtration, cleaning stored lubes, flushing after machine repair and rebuild, flushing during equipment commissioning and draining a reservoir or sump.

38. Prevent Lubrication Mistakes

How can you error-proof against lubrication mistakes? One obvious way is through tagging — applying color- and shape-coded tags to machines, transfer devices and storage tanks to ensure that the wrong oil or grease is not accidentally added.

39. The Drive for Cleaner Fluid

Fluid cleanliness is really no different than driving: They both require a clear understanding of the target, an ability to validate the target is being met, and a mechanism to take correct action when a deviation is observed.

40. Establish Lube Procedures

Lubrication procedures often vary from technician to technician based on convenience or preconceived notions of best practice. These methods of personal choice can depart significantly from OEM- or industry-defined best practices. The correct procedure needs to be established and routinely applied.

41. You Can't Buy Lubrication Excellence

Don't be lulled into a false sense of security that you can buy your way to lubrication excellence. Think about lubrication excellence as a change in the process of lubrication, rather than a solution that can be purchased, set and forgotten.

42. New Oil Is Seldom Clean

In the majority of cases, new oil is not suitably clean for most applications. Whether tote tanks, drums or bulk tanks are used, it is usually simple and inexpensive to install high-quality filters at the dispensing station to achieve a desirable cleanliness for the new oil.

43. Benefits of Storing Oil in Bulk Tanks

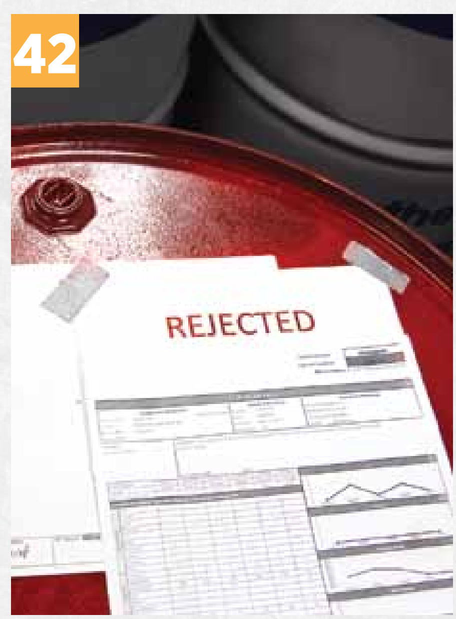
It is often easier to maintain low particulate contamination levels when oils are stored in bulk tanks because they are normally closed to the atmosphere and the oil is dispensed via a pump or tap.

44. Manage the Life Cycle of Your Lubricants

To extract the maximum value from lubricants and the lubrication program, lubricants must be properly managed from cradle to grave. This means adopting best practices for receiving, storing, dispensing, maintaining and finally disposing of used lubricants.

45. Eliminate Air in Lubricated Systems

It may be impossible to completely eliminate air from lubricated systems, but steps should be taken to reduce it as much as can reasonably be expected. Eliminating excessive air will likely give more life to your oil, improve system performance, and reduce wear and deposits.



46. How to Schedule Oil Changes

Don't schedule oil changes on large volumes of lubricants unless your oil dictates the need. Deploy oil analysis to determine the need and timing of the oil change instead of the calendar.

47. A Winning Combination

Reliability emerges from the optimum combination of quality lubricants and best-practice lubrication. Don't spend more money on premium lubricants hoping you can spend less on lubrication. There is no substitute for vigilant inspection, frequent and thorough oil analysis, and well-deployed lubrication practices.

48. Keep Tabs on Oil Filters

Keeping tabs on the performance of oil filters is essential to machinery reliability. Yet too often, many people in the maintenance field seem to be oblivious to the importance and methods of doing so. The best strategy is a proactive strategy.

49. Evaluate Your PMs

Preventive maintenance is among the most common root causes leading to the need to perform corrective maintenance. It need not be. Evaluate your PMs and eliminate tasks that fail to add value or actually create failure.

50. What to Consider Before an Oil Flush

The risks of not performing a needed oil flush include oil starvation from line restrictions and motion impediment of critical machine parts. And, postponing a needed flush can make matters substantially worse. Therefore, before planning and performing an oil flush, know the pitfalls and countermeasures.

51. Expand Your Wear Debris Universe

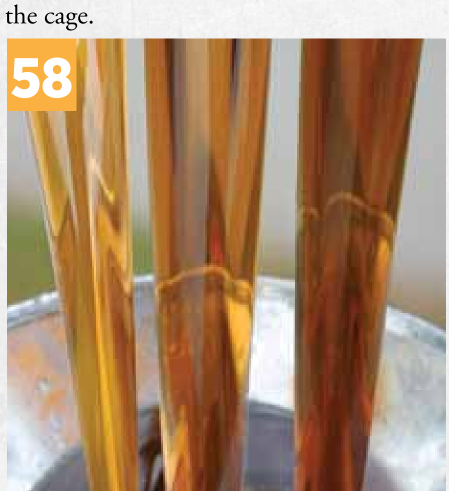
Take wear debris analysis to another level by digging deep to expand your wear debris universe. Develop new in-house skills and tactics that enable weak signals to be detected and virgin particles to be found and analyzed.

52. Monitor Water Contamination

Water is one of the most destructive contaminants in oil, and it would serve you well to monitor it on a consistent basis when dealing with sensitive or critical equipment.

53. Know the Bearing Type

Know the type of bearing being lubricated. A sealed bearing can't be regreased. Shielded or double-shielded bearings can be greased but slowly so as not to overpressurize the cavity and push the bearing shield against the cage.



54. Send the Right Signals

Sealable and reusable (S&R) containers serve as a visual sign of maintenance excellence. Conversely, use of fossilized oil cans serves as a constant reminder of maintenance neglect and program stagnation.

55. Use the FIFO Method

For both oil and grease, be aware of their respective shelf life. Exceeding OEM shelf life may render the product useless or severely hamper its performance. For this reason, it is best to use the first-in, first-out (FIFO) method.

56. Develop Lube Guidelines

Lubrication instructions need to provide guidelines that are simple and easy to understand but also contain specific details for how to perform a task according to prescribed best practice.

57. Employ Dynamic Route Planning

Instead of walking to and from the lube room, locating and gathering different tools, and handling paperwork before executing the work, employ dynamic route planning, which allows those tasks that logically fit together to be done at the same time, no matter what their prescribed frequency.

58. Make Lubricant Consolidation Easier

It can be difficult to consolidate lubricants based solely on their names, but when considering their performance properties, the consolidation efforts are clearer and easier.

59. Add a New Dimension to Oil Analysis

Effective oil analysis may be as much about data presentation as it is about the data itself. By leveraging the full resources of computer software, including multimedia, oil analysis can take on a whole new dimension.

60. Design a Better Lube Room

A properly designed lube room must be functional, safe, expandable and provide all necessary storage and handling requirements for the facility. Lube room designs should allow the maximum storage capacity without allowing for too much bulk oil and grease storage.

61. Consider Machine Criticality

Be fully aware of machine criticality. Changing the use or specification of lubricants in mission-critical equipment should not be done without skillful engineering.

62. Dangers of Overgreasing

Overgreasing can have many of the same negative side effects as undergreasing, plus the added cost of high lubricant consumption. Do not exceed the properly calculated amount of grease when performing greasing activities.

63. Continuously Improve Your Lube Program

A lubrication program needs constant refinement and continuous improvement. It is easy to slide back to the old ways of doing things if not careful, especially if the organization has a high turnover rate in the labor force.

64. Handle Oil Drums with Care

Avoid damage to oil drums and other large containers during handling. Negligent handling can cause leakage or ingression of dirt.

65. Make Modifications for Reliability

Lubrication-enabled reliability is not high science. Any maintenance organization can accomplish it with proper training,

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planning and deployment. Much of it is behavior based and just good old common sense. It's about making modifications of people, machines, procedures, lubricants and metrics.

66. The Value of Machine Inspections

Simple inspections on all types of machines provide invaluable information as to their condition as well as reassurance that they are operating in a reliable manner.

67. Check Your Additive Package

Whether they are enhancing, suppressing or imparting new properties to the base oil, additives play an important role in the lubrication of machinery. When the additives are gone, they're gone, so don't forget to check your additive package.

68. Not Just Any Lubricant Will Do

Machines don't just need some lubricant or any lubricant. Rather, they need a sustained and adequate supply of the right lubricant.

69. Know the Factors That Influence Oil Life

The end of oil life is influenced by a complex array of factors. Many of these can be monitored, controlled and used to optimize the oil drain interval.

70. Check Sight Glasses

It's not enough just to put a sight glass on a machine and walk away. These devices should be monitored. They are windows into what is happening with your oil and can give you a first-hand account of any problems that are occurring.

71. Keep Oil Clean

Keeping the oil clean is the first order of business if extended oil replacement intervals are the goal. In turn, achieving extended oil replacement intervals often makes it economical to use superior-quality synthetic lubricants.

72. Advantages of Hard-piping Machines

Hard-piping machines to a fixed oil supply is one way to address a lack of available labor to handle oils. Since this reduces the

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number of hours it takes to perform an oil change, the plant can run more efficiently with the staff it already employs.

73. Contamination Control Advice

The control of contamination in machinery is pointless if contaminated or below-specification lubricants are used, or if clean lubricant is being handled so carelessly that it enters machines in a contaminated state.

74. Create Electronic Lube Procedures

Get your lubrication procedures in an electronic form, preferably on your company-wide intranet or onto an internet account for those moving toward web-based application support. When procedures are electronic, they can be updated globally, attached to work orders and linked to like machines in your computerized maintenance management system.

75. Add Accessories

If you truly want to make strides toward becoming a world-class program, you will need to make equipment modifications. By adding accessories such as desiccating breathers, quick connects, external level gauges and sample ports, you can transform a small gearbox to world-class standards in terms of contamination control, maintainability and reliability.

76. Share Responsibility for Reliability

Reliability needs to have shared responsibility. It must be fixed in the DNA of the machine as well as in the minds of operators and maintainers. It's like a reliability chain – every link in the chain must be equally strong for the chain's full length to bear the load.

77. Monitor Wear Debris

By vigilant monitoring of wear debris as well as understanding the forces at play

during the break-in period, you can ensure that your machines will have a longer life and experience fewer breakdowns.

78. Don't Neglect Lubricant Disposal

Proper handling techniques do not end when the oil has been put into service. Once the life of the oil has been exceeded, you must ensure the lubricant is captured and disposed of both safely and in an environmentally friendly way.

79. Manage Change

Your lubrication strategy will depend on

the scope of the project, the size of your company and the cultural maturity of your organization. The bigger the organization and the project, the more relevant a good change-management initiative becomes, and the more resources will be needed for a seamless and faster implementation.

80. Ensure Multiple Sampling Locations

Most circulating and hydraulic systems should have both a primary and secondary sampling location to ensure that any identified failure mechanism can be tracked back to the component causing the problem.

81. Value Knowledge and Skill

Make education and job competency a big deal. Knowledge and skill should be appreciated, respected, celebrated and reinforced. Use education as a team-building tool to bring people together with shared goals and create opportunities for coaching.

82. Control Leaks

Leakage control makes good sense for a number of reasons. Not only are there lubricant consumption savings but also reliability and safety benefits.

83. Trend Oil Analysis Data

Simply obtaining a snapshot of data from an oil sample is essentially worthless without something to which to compare it. This is why trending data in oil analysis reports is so beneficial. It not only allows you to determine if the current oil properties are unfavorable but also if they will become unfavorable in the near future.

84. Visit Your Lubricant Blender

If you have the opportunity, visit your blender's plant and check out their processes. See if they are putting the same emphasis on keeping lubricants clean as they are on blending and formulation specifications.

85. Match Synthetic Oils to Machinery Needs

Synthetic oils can be tremendous assets to any lubrication program, but they must be matched to the machinery's needs to get the optimum benefit from them. When making the transition from mineral base fluids to a synthetic base, be sure to flush the system to minimize any residual compatibility issues that may remain.

86. Develop a Plan for Used Lubricants

All plants should have a coordinated plan for managing used lubricating oil, including how much oil is reclaimed and how much is recycled.

87. Emphasize the Reasons for Change

When implementing change, such as when designing or redesigning a lubrication or reliability program, people need to know why the change is being made and how it will affect them. Understanding the need for change is the first step in creating new behaviors within a facility.

88. Question Viscosity Recommendations

Don't assume the lubricant in your machine has the right viscosity simply because it is the one specified in the machine's service manual. Challenge conventional recommendations for viscosity. Some machines are operating at conditions far afield from that intended by the machine designer.

89. Identify the Cause of Oil Leakage

Any time there is oil leakage in a system, there's a reason for it. The entire system should be analyzed, and the cause of the leaks identified.

90. Handle Lubricants Carefully

Most lubricants should be handled with care and proper personal protective equipment (PPE). Create a barrier between you and the lubricant. Wear gloves and safety glasses as well as oil- or chemical-resistant boots. If possible, keep all exposed skin covered.

91. Determine the Correct Oil Level

The best time to decide on the appropriate oil level for your equipment is when the machinery first arrives at your facility. Once the correct oil level is identified, it must be clearly marked in the field.

92. Watch for Foam

Contaminants frequently affect a lubricant's foam tendency and stability as well as water separability. If you detect more foam than normal or demulsibility issues, it may be an indicator of lubricant contamination.

93. Find the Source of a Heat Problem

The next time a heat problem occurs in one of your systems, look for oil that is flowing from a higher pressure to a lower pressure in the system. That's where you'll likely find your problem.

94. Keeping Oils Fluid

In some applications, it is nearly impossible for oil to remain fluid at all ambient temperatures. In these situations, the use of an oil heater is recommended.

95. Consider Water-based Fluids

Water-based fluids are an alternative when fire resistance is imperative and typical lubricant properties like viscosity or lubricity are less important.

96. Test New Oils

It is critical to your oil analysis program that you sample and test oils upon receipt. The possibility of receiving the wrong oil or lubricants that do not meet the required specifications is very real.

97. Choose the Right Lubricant to Reduce Air Pollution

One of the more overlooked aspects of a lubricant is its ability to influence environmental emissions. By selecting the proper oil, you can help to reduce some of the harmful contaminants that are spewed into the environment without sacrificing the needs of the machine or the performance of the lubricant.

98. Invest in Training

Even if you have invested large amounts of resources in your program, you may still need to invest in training for your team members in order for them to execute your procedures properly.

99. Check Your Oil Analysis Lab

Most oil analysis practitioners assume the data from their laboratory is accurate and irrefutable, but this may not always be the case. Routine checking of your lab is crucial.

100. Water Contamination Can Affect Oil Viscosity

A common misconception is that water will reduce the viscosity of a lubricant. In fact, if an excessive amount of water is "whipped" into the oil in such a way that it forms a stable emulsion, the viscosity can increase, sometimes dramatically so.

101. Certification Provides a Host of Benefits

A good lubrication certification program includes competence that is not only specialty-specific, but also focuses on core abilities (application-oriented) and establishes and validates a standard skill level for practitioners. Certification increases confidence, proficiency and performance (know-how applied).

TEST YOUR KNOWLEDGE

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

1. Anti-wear and extreme-pressure additives function by:

A) Reacting within the bulk oil to form wear protecting chemicals.
B) Are used in the same oil formulations.
C) Reacting with the iron surface due to frictional heat to reduce surface damage.
D) Stopping the wear reaction pathway.
E) Altering the surface tension of the oil.

2. Which hardware is the best for sampling pressurized lines above 500 psi?

A) A long dead-leg of piping with a plug at the end
B) A pressure-regulating valve or a helical coil connected to a minimess valve
C) A capped drain plug
D) A minimess valve located on an elbow
E) A minimess valve located on a straight length of pipe

3. Upper and lower alarm limits are generally needed on which oil analysis test results?

A) Acid number
B) Base number
C) Viscosity
D) Flash point
E) RPVOT

ANSWERS

1. C
Anti-wear and extreme-pressure additives react with a component's surface due to high frictional heat from a low shear-strength film that protects against adhesive and abrasive wear. Therefore, the correct answer is C.

2. B
These two methods help control (reduce) the pressure to safely collect samples.

3. C
Viscosity upper and lower alarm limits are needed to ensure that lubricated components run on the correct oil film. Viscosity that is higher than the system requirements leads to churning as well as high temperature and its associated problems. On the other hand, a lower viscosity may not be able to carry the load, which causes wear and in some cases component failure. For acid number (AN), the upper limit is normally monitored by comparing it to the AN value of new oil. For the base number, flash point and RPVOT, lower limits are generally monitored by comparing them to the values of new (reference) oil.

Al Smiley | GPM Hydraulic Consulting

How Directional Valves Affect Oil Flow in Hydraulic Systems

Directional valves are some of the most fundamental components of a hydraulic system. When a directional valve is sized for an application, it must be large enough to handle the volume of oil necessary to operate the cylinder or hydraulic motor. For applications that require less than 10-15 gallons per minute of oil flow, a direct solenoid-operated valve is used (as shown in Figure 1). To shift the valve spool, current is applied to the valve coil. This creates magnetism within the coil, which pulls in the plunger. The plunger then acts on a pushpin, which shifts the valve spool. The solenoid generates approximately 30 pounds of force to shift the spool. Once the spool shifts, oil is ported through the valve and then to the cylinder or hydraulic motor.

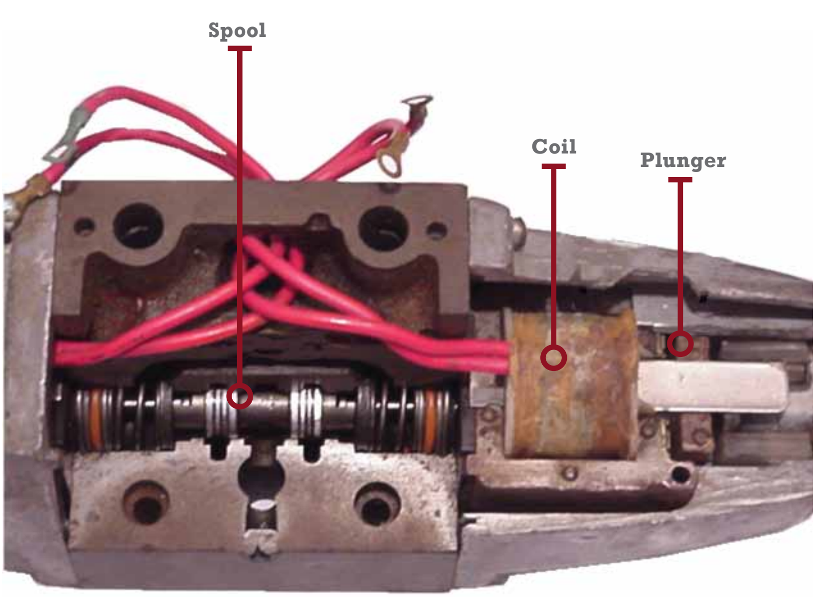


Figure 1. A direct solenoid-operated valve

Two-stage Valves

On systems where higher flow rates are required, two-stage valves are normally employed. A typical two-stage proportional valve is shown in Figure 2. The top valve is known as the pilot valve. The purpose of the pilot valve is to direct pilot pressure to shift the main spool. Since these are larger in size than the direct operated valves, more force is needed to shift the main spool. Instead of using very large solenoids that demand high current to operate, hydraulic pressure is utilized to shift the main spool.

There are springs on both sides of the main spool which hold it in the center position when the pilot valve is not shifted. The springs are usually rated between 50-115 pounds per square inch. When the main spool on this particular valve is in the center position, the "P," "A," "B" and "T" ports are blocked.

Two-stage valves may be internally or externally piloted. In Figure 2, notice the pilot plug (circled in red) on the left. This plug blocks flow from the "P" port of the main spool to the "P" port of the pilot valve. When this plug is installed in the valve, pilot pressure must come from an external source and be connected to the "X" port on the valve manifold. Many presses and mobile equipment employ a separate pump for supplying the pilot fluid. In some cases, oil is ported downstream of the pump through a pressure-reducing valve and then to the "X" port. By utilizing a separate pump or pressure-reducing valve, a lower pressure is used to shift the main spool.

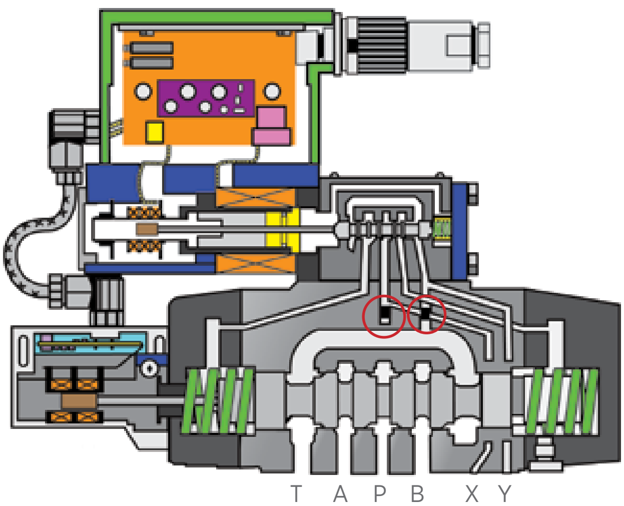


Figure 2. A typical two-stage proportional valve

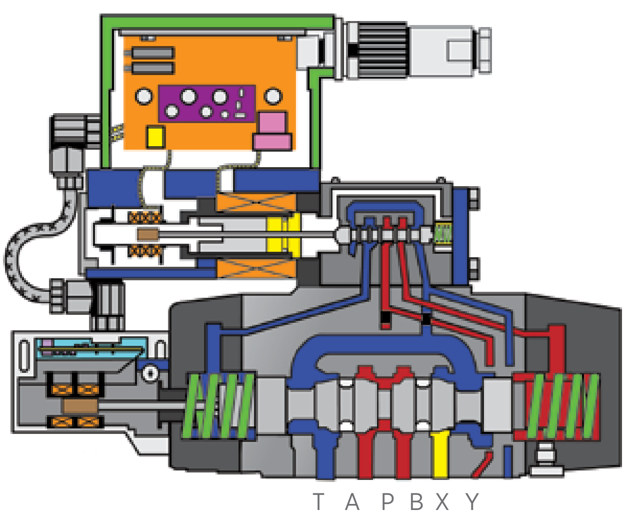


Figure 3. Current applied to the pilot valve coil

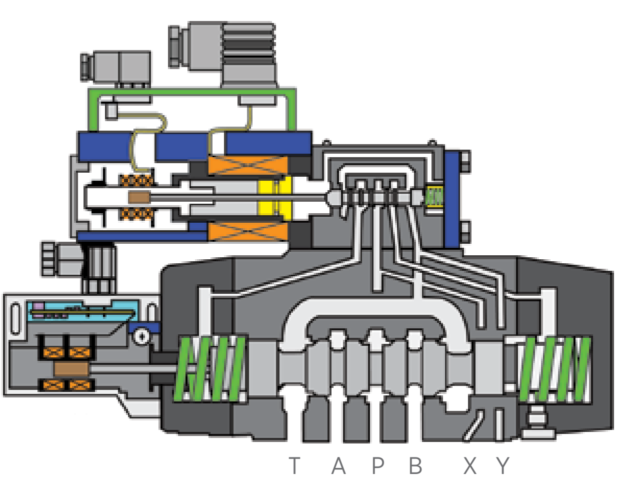


Figure 4. A main valve housing with the pilot plugs removed

This prevents damage to the spool instead of using the higher system pressure to shift the valve.

When current is applied to the pilot valve coil (as shown in Figure 3), magnetism in the coil causes the pilot spool to shift to the right. Pilot fluid then flows from the "X" port through the pilot valve and to the pilot cavity on the right side of the main spool. Once the pilot pressure builds up enough to overcome the spring acting on the opposite side, the main spool will shift to the left. Once shifted, the system volume at the "P" port of the main spool will flow through the "P" and "A" ports and then to the actuator (cylinder or hydraulic motor). The oil that exhausts out of the actuator flows into the "B" port, which is connected to the "T" port inside the valve. The oil will then flow out of the "T" port and return to the reservoir.

When the main spool shifts (as in Figure 3), the oil on the left side of the spool is ported through the pilot valve spool. Notice in Figure 2 that the circled pilot plug on the right is blocking the flow passage from the tank port of the pilot valve to the tank port of the main spool. When this plug is installed, a line must be connected to the "Y" port on the manifold to externally drain the valve. This provides a flow path for the oil that exhausts out of the main spool's pilot cavity and pilot valve to return to the tank.

In some instances, both pilot plugs are removed from the main valve housing. In this case, there are no external lines connected to the "X" and "Y" ports on the valve manifold. In Figure 4, the pilot plugs have been removed. This opens the internal pilot passage from the "P" port of the main valve to the "P" port of the pilot valve. Once the pilot valve is shifted, system pressure is directed through the pilot valve to shift the main spool, as previously described. When the main spool shifts, the oil that exhausts out of the opposite pilot passage will flow through the pilot valve and then into the tank line of the main spool. This is what is known as an internally piloted and internally drained valve. Valves can be internally drained as long as there are no flow surges or pressure spikes in the tank line that affect the shifting of the main spool.

Replacing Two-stage Valves

When replacing a two-stage valve, it is important that the piloting and draining arrangements are the same as the removed valve. This applies to proportional and AC voltage-operated valves. In certain instances, valves are internally piloted and externally drained. In other cases, they may be externally piloted and internally drained. Refer to the valve's part number to ensure the valve you are installing is the same as the one that was removed. Just because it mounts on the same manifold does not mean it is the same valve. For example, a closed-center, externally piloted and drained Vickers valve has the following part number: DG5S8-2C-E-T-30. The "E" designates that the valve is externally piloted, while the "T" indicates that it is internally drained. If a DG5S8-2C-E-30 valve is put in its place, the valve will not work because it is externally drained. This means the internal drain port is plugged

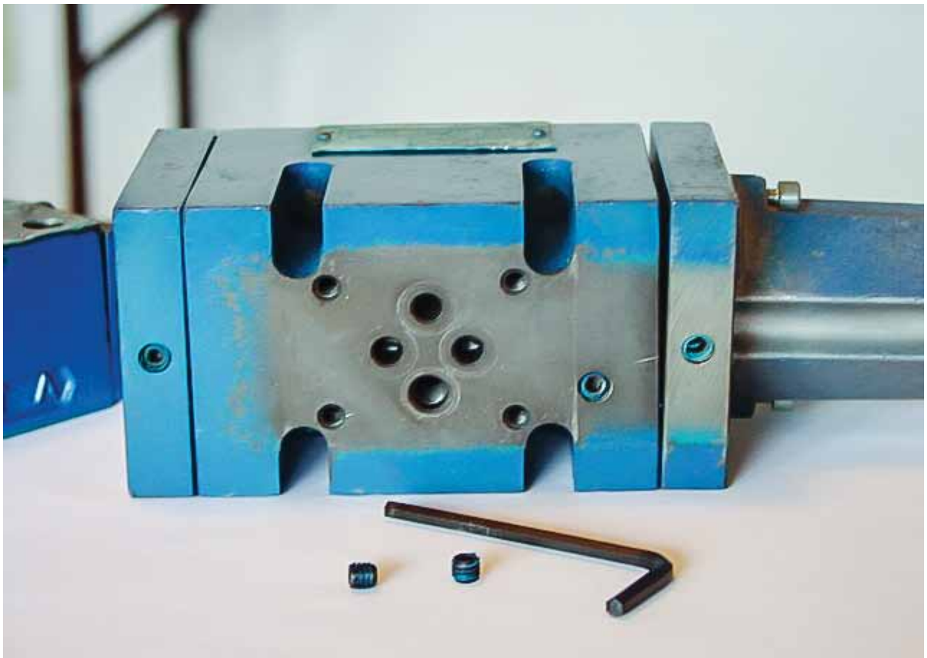


Figure 5. Pilot plugs can be removed with an Allen wrench.

and the main spool will not shift, since no line is connected to the "Y" port.

I recall an instance at a plywood plant where they had replaced a valve on the lathe with the exact part number as the valve they had taken off. When the new valve was installed, the spool wouldn't shift and allow the spindle cylinder to extend and clamp the log. After changing several other components, they found that although the part number was the same, the equipment manufacturer had removed the pipe plugs from the original valve but failed to change the part number. Once the pipe plugs were removed, the valve and spindle cylinder operated normally.

If you and your vendor do not have a valve in stock with the configuration you need, a valve usually can be converted by removing or installing pipe plugs. On the proportional valve used in the examples, the pilot plugs are accessed by taking the pilot valve off the main stage and removing them with an Allen wrench (Figure 5). On some valves, the pilot pressure plug is accessed through the "P" port of the main spool.

Another important thing to remember is that pilot and drain lines and passages are small and can plug. If a new valve is installed and the actuator will not operate, check the pilot and drain passages. This can be done by removing the pilot valve from the main valve's housing and disconnecting the pilot and drain lines from the manifold. Blow air into the pilot and drain line passages on the manifold. If air comes out the pilot and drain ports on top of the main spool, the passages are clear.

With a greater understanding of how these valves work as well as their proper applications, you should be able to better troubleshoot your hydraulic systems for improved equipment reliability and availability.

About the Author

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

Wes Cash | Noria Corporation

Best Practices **for** Lubricating Paper Machines

"**MOST PAPER MACHINES HAVE HUNDREDS, IF NOT** THOUSANDS, OF LUBE POINTS THAT REQUIRE PERIODIC APPLICATION OF OIL OR GREASE."

In the current electronic age, many people think of paper as a dying industry. While it's true that more businesses are going "paperless," consider all the paper products that are still used in homes and offices every day. These would include things such as paper towels, hygiene products, diapers, etc. All of these items are made in paper factories that were either built for these products or have been retooled to manufacture them. In addition, these segments of industry are growing, causing the demand to keep the machines running at an all-time high.

One of the best ways to achieve fault-free operation of paper machines is to ensure the proper lubricant is applied to the frictional surfaces. Most paper machines have hundreds, if not thousands, of lube points that require periodic application of oil or grease. There are bearings, gears, couplings, journals, cylinders and valves which must all receive the correct lubricant to survive the rigors of the paper-making process.

Circulating Systems

Since paper machines often have a high number of lube points in close proximity, they typically are lubricated with circulating oil. In this setup, oil is pumped from a central reservoir throughout the system, with supply piping running to the lube points and return piping channeling lubricant back to the reservoir. This type of lubrication system is advantageous for a variety of reasons.

Machines lubricated with circulating oil tend to operate cooler than those that are splash-lubricated. This reduced operating temperature helps extend the life of the lubricant and the lubricated component. Besides its cooling function, circulating oil also can reduce the labor costs of lubricating each point individually. Although a lubrication technician must monitor each line to ensure the proper volume is being applied, physically adding oil to every point is not required with these systems.

Circulating systems employ pumps that force oil where it needs to go. Since the oil is pumped, there is an opportunity to filter it and remove harmful contaminants that may damage sensitive machine components. It is not uncommon to find multiple filter locations within paper machine oil systems. Filters located in the supply line can remove contaminants before the oil goes to work. Filters in the return line help scrub contaminants that were recently ingressed by the process. Off-line filters continually circulate oil in the reservoir through filters to further polish the oil. When all of these filters are utilized in unison, not only will the circulating oil be very clean, but vast amounts of machine wear can be reduced.

Paper machine circulating systems normally hold hundreds if not thousands of gallons of oil. With this volume, the oil has adequate residence time in the reservoir, allowing particles and water to fall out of suspension, air to separate, and the oil to cool. There is also a larger volume of additives to enhance the oil's lubricating properties. All of these factors can combine to significantly extend the life of the oil and equipment.

Bearings

Along with serving multiple functions inside the circulating system, paper machine lubricants must lubricate numerous component types. Bearings are perhaps the most common, particularly roll bearings tied to the centralized lubrication system. These rolls help transport, size and dry the paper. As the rolls turn, the bearings must be simultaneously lubricated and cooled. The flowing oil transfers heat away from the bearing and provides the required lubricating film for smooth, consistent operation. If the bearing housing allows contaminants into the system, the moving oil can carry these contaminants out of the housing to the filters or reservoir to be settled out of the system.

Gears

In some paper machines, the centralized lubrication system also lubricates gearing that drives certain sections of the machine. Gears present a different challenge than bearings in that the load tends to be much higher. This leads to greater stress on the lubricant film and generally requires the use of additives to protect the machine surfaces. The gears are commonly simple spur gears that mesh together. They can handle more chemically active lubricants without the risk of corrosion or chemical degradation to the gear surface. These gears often have a more defined pitch line, which makes the building of a lubricating film easier.

Press and Calender Sections

During the paper manufacturing process, wet pulp is placed onto a web or screen and then transported through the machine where it is dried and fashioned into the desired thickness. The press and calender sections are where the finished product's thickness is usually formed. In these sections, the paper machine lubricant may also be used as a hydraulic medium. The oil provides the force required to push the rolls together, determining the paper's thickness. The hydraulic pumps and valves in these areas of the machine are highly contaminant sensitive, so the oil must be kept relatively clean throughout its operating life to ensure the life of the components.

Leakage

With hundreds of pipe connections, lube points and machine interfaces, paper machines frequently are plagued by lubricant leaks. This leakage also leads to two other problems: capturing the leaked lubricant and continuously topping up the oil reservoir.

Capturing the lubricant normally is achieved with pans or rails, which collect and funnel the used oil to a collection container. Some facilities have attempted to reclaim and recondition this leaked oil in order to reintroduce it into the machine. Provided the base oil and additives are still healthy, this can be a viable option, but it does have inherent risks. If the oil cannot be fully filtered to remove the gross contamination, it will become yet another source of contaminant ingression for the lubrication system. Also, the practice of capturing and then reconditioning the lubricant may not be cost-effective. The amount of effort required to clean the oil to an acceptable level would far outweigh the cost of buying new oil and adding it to the reservoir.

Continually topping up the lubricant can help to extend the time between oil changes. The new lubricant brings with it new additives and dilutes any damaged base oil, thus improving the lubricating properties of the oil overall. Some paper machines never undergo a full drain-and-fill of the oil reservoir because of this practice of adding new oil as the used oil leaks out.

Paper Machine Oils

Lubricants used in paper machines are specially formulated to handle the rigors of the application. These oils tend to have high levels of additives to combat water contamination and support the loads in working zones. The lubricants generally consist of antioxidants, rust inhibitors and anti-wear additives. In certain cases, they may also have detergent additives to help prevent buildup on machine surfaces due to the breakdown of the oil.

Viscosity is the most important physical property of a lubricant and must be properly selected for the application. Paper machine lubricants typically have a viscosity of more than 150 centistokes (cSt). This viscosity allows the oil to be pumped but still provides a thick enough lubricating film to protect the bearings. If the viscosity is too low, the lubricated components will suffer accelerated wear and have a shorter

By the Numbers:
4,390 paper manufacturing facilities are currently operating in the United States, according to the American Forest & Paper Association

lifespan. Conversely, if the viscosity is too high, additional power is needed to pump the lubricant. Temperatures may also run higher due to viscous drag.

Demulsibility is another critical lubricant property to consider. The oil must be able to readily separate from any water picked up during its journey through the system. The lubricant should also be able to transport this water to the reservoir or a settling tank, where it sheds the water and continues its way through the lubrication circuit.

Contamination Control

Filters should be employed on every paper machine circulating system. Without the ability to remove contaminants, the oil and machine surfaces will degrade rapidly. Many paper mills choose filters with a focus on smaller particles, such as 10 microns or less, as they often cause the greatest damage. The selected oil must also be able to pass through the filters at all expected operating temperatures. This is largely a function of the viscosity and viscosity index. Moreover, as oil flows through the filter, the additives must remain in the oil and not be stripped by the filter. Paper machine oils require many additives, so look for lubricants that are filterable and retain their additives during the process.

Usage Considerations

The intended use of the finished paper product can also be a factor in lubricant selection. In cases where the paper is used for food packaging or hygiene products, food-grade lubricants may be required. This will limit your lubricant options as well as the additives that can be used. Mandatory compliance with the Food Safety Modernization Act (FSMA) has made this issue even more important. Be sure to ask your internal FSMA champion what the best course of action is for minimizing any incidental contact of the lubricant with the product.

Grease Lubrication

Depending on the paper machine's design, some bearings may be lubricated with grease. There are specific greases formulated for these applications as well. They typically utilize a higher viscosity base oil (above 220 cSt), have high water resistance and are white so as not to impact the color of the finished product if any grease would happen to fall onto the paper during its trip through the machine.

Automatic Lubrication

Although certain paper machines may be greased one point at a time by a lube tech, others are tied into large, centralized greasing systems. These systems dispense grease from a central reservoir to every point using injectors. The injectors set the volume applied at each point. When automatic greasing systems are employed, the lines and each injector must be inspected to verify that they are working properly.

Oil Changes

With large volumes of oil at stake, many mills choose to change their paper machine oil based on its condition rather than taking a time-based approach. This allows them not only to get the most life out of their oil but also to track and trend variables like wear debris and contamination. Normal oil analysis test slates can be used to examine the particle count, water content, viscosity, additives and wear metals. Other tests, such as varnish potential, foam tendency and demulsibility, should also be conducted periodically to look for a breakdown of the base oil or any changes in the oil's physical properties.

Lubricant Selection

Selecting the right lubricant for any application can be challenging. The same is true for paper machines. As this industry continues to evolve, the lubricants used in these machines will as well. However, by following the simple practice of keeping lubricants clean, cool and dry, you can ensure the best possible life for your lubricants and machines.

About the Author

Wes Cash is the director of technical services for Noria Corporation. He serves as a senior technical consultant for Lubrication Program Development projects and as a senior instructor for Noria's Oil Analysis II and Machinery Lubrication I and II training courses. Wes holds a Machine Lubrication Technician (MLT) Level II certification and a Machine Lubricant Analyst (MLA) Level III certification through the International Council for Machinery Lubrication (ICML). Contact Wes at wcash@noria.com to learn how Noria can help you implement best practices for lubricating machines at your facility.

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

Tip for Replacing **Oil Filters**

When replacing top-suspended spin-on or threaded canister-type filters, fill them with fresh oil before installation. This will reduce the amount of time that the engine or machinery undergoes dry start-up by having an extra amount of oil available. In some cases, it could also prevent filter damage when a gush of high-pressure fluid hits a dry element.

How to Speed up **Oil Changes**

Use your circulation pump to speed up oil changes in large circulation systems. Install a tee and two isolating shut-off valves downstream of your circulating pump. When draining your reservoir, connect the hose to this tee and use your pump to move the oil from your reservoir to the scrap oil truck. This is especially helpful for large, below-ground level systems.

Pay Attention to **Your Oil Level Indicator**

When rolling-element bearings are lubricated from oil held in a sump, attention to the oil sump level indicator will not only bring savings in terms of extended bearing life, but also will lead to reduced bearing temperatures due to churning and metal-to-metal contact resulting from possible oil starvation. As a general rule, the lowest rolling element should be half covered with oil when the bearing is stationary. This may seem like a simple rule to observe, but it is surprising how often it is completely overlooked.

Did You Know?

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

MachineryLubrication.com.

Have Some TIps?

If you have a tip to share, email it to

editor@noria.com.

"What are the top three characteristics you **look for when considering an oil analysis laboratory** (i.e., turnaround time, price, quality, capabilities, etc.)?"

Selecting an oil analysis laboratory can be daunting if you don't know where to begin. Once you make the decision to initialize an oil analysis program at your plant or to find a quality lab other than the one offered by your oil supplier, there are several important factors to consider. The following three attributes will be key to building a successful relationship with your oil analysis lab.

Quality of Testing

Many laboratories struggle to meet their customers' expectations because of mishaps in testing procedures. A quality lab will make efforts to follow ASTM or ISO test procedures in order to maintain the utmost accuracy in analysis interpretation. Be sure to find out whether there will be any deviations to the standardized test procedures, which should be followed for all types of testing instruments. Also, do not be afraid to ask questions.

Data Interpretation

An oil analysis report is not intended to be just a sheet of paper with raw data results. These tests can be quite complicated, so it may not be easy to determine an obvious concern, let alone an inconspicuous or unusual one. The best oil analysis reports come complete with a full analysis interpretation summary. This should not be computer-generated but tailored by a specialist. The report should also have graphs that show trend data, along with a comparison to the baseline, as well as critical and cautionary limits. Finally, the report should feature a layout that is easy to understand.

Customer Service

The services an oil analysis laboratory offers should go beyond those relating simply to the oil samples. The individual in charge of receiving the reports at the plant should be in frequent communication with those who interpret data at the lab to collaborate on possible explanations for data anomalies and to obtain expert advice on determining the best course of action. The laboratory should also offer a hotline to provide quality customer service whenever you need it.

Please note that price is not included in this list, as you should expect the cost of laboratory services to remain competitive. Also, in regard to price, it is important to keep in mind that a single machine failure that is avoided through oil analysis can justify an entire year or more of the oil analysis program.

"Can you offer any advice on selecting desiccant breathers for gearboxes in the mining industry?

Which factor plays more of a role in breather selection: the sump headspace above the oil level, ambient conditions like high humidity or a dusty environment, the machine type (mobile unit or fixed installation), the type of oil and its application, or the oil's cleanliness requirement?"

Desiccant breathers are great contamination control accessories for machines that would otherwise be breathing in dirty, wet air. These devices allow for the air being ingressed by the machine to be cleaned of particulate matter and also dried to help control the amount of water in the oil. This becomes very important in critical machinery as well as those that are in harsh environments where the oil may become contaminated and break down quickly.

These breathers have a particulate filter phase and a moisture absorption phase. Both of these phases are essential not only for the health of the lubricant but also for the health of the machinery. Solid particulate contaminants can lead to machinery failure mechanisms such as three-body abrasive wear. Moisture contamination can result in adhesive failure mechanisms and increase the rate at which lubricants break down.

Oil by nature is hygroscopic, which means it will absorb moisture readily from any source, including from humidity in the air. By utilizing a desiccant breather, you can reduce the amount of moisture in the air that is entering the system.

The headspace is important to keep in mind, as it can help determine the amount of "breathing" that will occur inside the machine. Therefore, it is imperative to understand how much the headspace can fluctuate. For instance, the headspace in a splash-lubricated gearbox will fluctuate less than that of a hydraulic system reservoir where there are large volumetric changes within the sump. This volumetric flow rate must be within the breather's capabilities, or it may cause a vacuum or pressurization condition inside the component.

The environment in which the machine operates should be considered as well. For severe environments, such as those with water spray and large amounts of dirt, select a desiccant breather that can handle the expected amounts of contamination. For the most severe environments, you might choose a breather with a check valve or bladder assembly to help prolong the desiccant's life.

The cleanliness level required by the machine must also be taken into account when determining the desired desiccant quality. Of course, the more critical machines should receive the most attention.

Considering all of these variables will provide the most effective way to select a desiccant breather. While a number of options are available, some are better suited for certain situations. Remember, it is far better to provide more protection than needed rather than to skimp on quality in order to save money.

If you have a question for one of Noria's experts, email it to editor@noria.com.

Devin Jarrett | Noria Corporation

4 Grease Tests for Centralized **Lubrication Systems**

"The best approach is to start with the grease and **then design a system that works with the lubricant.**"

When designing a centralized lubrication system, which comes first: the system or the grease selection? Most people begin with the system and then find a grease that is suitable for it. However, the best approach is to start with a grease that serves the needs of the machine and then design a lubrication system that works with the lubricant.

What's in a Grease?

Before considering which tests should be performed to help select the right grease, a basic understanding of grease formulation is needed. During Noria's training courses, the class is often asked, "What is grease?" Typical responses include "really thick oil," "a paste-like lubricant," etc. According to ASTM D288, grease is defined as "a solid-to-semifluid product of dispersion of a thickening agent in a liquid lubricant. Other ingredients imparting special properties may be included."

Basically, a grease is comprised of three parts: the base oil, additives and a thickener. The base oil may constitute between 70 to 95 percent of the grease. It provides the grease's viscosity and film thickness, and is the foundation upon which the grease is built. A mineral, synthetic or vegetable-based oil may be used in a grease. The oil type is selected based on the desired properties needed for the application.

Additives are employed to impart new properties or to suppress or enhance existing properties of the base oil. They can make up between 0 to 10 percent of the grease and typically offer protection to rotating equipment during startup and shutdown. Additives can also help protect against rust and corrosion.

The thickener is critical, as it is the vessel that delivers the base oil and additives to the equipment. It can represent between 3 to 30 percent of the grease. There are many types of thickeners, but most fit into two categories: simple soap or complex soap. Other thickeners, such as polyurea, clay and silica, do not fall into these categories but also act as thickening agents in specialty grease formulations.

Selecting a Grease

Now that you have a better understanding of how grease is formulated, let's look at four tests that can reveal how the grease's ingredients will interact inside a lubrication system. The first property to consider is the base oil's apparent viscosity.

1. Apparent Viscosity Test

Viscosity is the most important property of any lubricant. To determine the required base oil viscosity, you must identify the optimal viscosity for each system component you plan to lubricate. A grease's base oil viscosity is noted on its product data sheet. Once you have established the required viscosity, test the grease to find its apparent viscosity. This relates to mobility of a grease moving through lines and components of a centralized lubrication system. Apparent viscosity involves the collective influence of the base oil, additives and thickener. The ASTM D1092 standard test is ideal for measuring the apparent viscosity of lubricating greases. It can help predict pressure drops in a centralized lubrication system under a steady flow and at a constant temperature. The results of this test are reported in centipoise.

50%

of lubrication professionals use centralized lubrication systems at their plant, based on a recent survey at MachineryLubrication.com

2. Cone Penetration Test

You also will need to determine the required consistency or NLGI grade of the grease. A general starting point is the expected operating temperature and speed factor. Other variables that can impact the required consistency include the bearing type, thickener type, base oil viscosity and base oil type.

A cone penetration test (ASTM D217) is frequently employed to gauge a grease's consistency. It utilizes a weighted cone to penetrate a block of grease, with four standards of testing the grease's consistency: undisturbed, worked, prolonged worked and block. The focus of this article will be on the undisturbed and worked tests.

An undisturbed penetration test provides information on the grease's consistency during storage conditions. Worked penetration tests reveal what the consistency of the grease will be while inside a machine or component. This is imperative with centralized grease systems, as the grease may be in "storage conditions" for a prolonged period before it reaches the component. Storage conditions apply to grease both while it is in a drum or other storage container and in supply lines.

Among the factors to keep in mind when planning a supply-line path are the temperature exposures, vertical paths, and the time it takes for the grease to enter the supply line and reach its destination. These factors can cause the base oil and thickener to separate, leading to oil starvation in the equipment.

3. Structural Stability Test

Next, assess how stable the grease will be as it is subjected to operating conditions. You must know if the grease will be able to handle the intended loads and for how long before it begins to fail. The ASTM D1831 structural stability test method utilizes a penetrometer test of unworked grease. The same grease is then worked in a standard roll stability device for two hours at a temperature between 20 to 35 degrees C (68 to 95 degrees F). The grease is then put through the penetrometer test again. The difference between the two tests is used to measure the effect of low shear stability of the oil in the grease.

4. Ventability Test

The final test relates specifically to matching the grease to the lubrication system's design and the size of tubing to be utilized. Depending on how far the grease will be pumped, the tubing size can significantly impact the system's cost. A ventability test will identify the supply-line diameter required for a specific grease. It can also assist in determining whether the grease can be used in a centralized lubrication system and whether grease valves and injectors will function properly. The test pressurizes grease to 1,800 psi in a 25-foot coil. After the grease has stabilized at 1,800 psi, a relief valve is opened and the pressure gauge is read after 30 seconds. Matching this pressure reading to a supply-line reference chart will provide the diameter needed.

Also, when choosing a supply line, be sure to select an appropriate material. Some metals, such as copper and galvanized steel, can have severe effects on the grease's composition.

It should also be noted that when grease is subjected to certain conditions under pressure, it can undergo what is called cake-lock. This occurs when the grease thickener's movement is restricted, leading to a block in the line or component. The base oil may still flow, but the thickener will not. Without the thickener, the base oil may not reach the working zones of the components, thus creating lubricant starvation. All three parts of a grease (the base oil, additives and thickener) can contribute to cake-lock, and no single element can increase or decrease the possibility of the condition.

With the results of these tests, you should now have the necessary information to make an informed decision. Consider your budget for a centralized system when making your grease selection but design the system around the grease. Avoid common mistakes such as having a supply-line diameter that is too small or too large, using too much or too little pressure to push grease through the supply lines, and sacrificing essential grease properties just so the lubricant can flow through the system.

Now, if you are asked which comes first when designing a centralized lubrication system, the system or the grease, you'll know the right answer. ***MLI***

About the Author

Devin Jarrett is the program manager at Noria Corporation. He holds a Machine Lubrication Technician (MLT) Level I certification through the International Council for Machinery Lubrication (ICML).

MARUTI SUZUKI

Maruti Suzuki India expands reach of Ecstar products

The country's largest car maker Maruti Suzuki India (MSI) expanded the reach of its Ecstar branded lubricants, coolant and car care products with the introduction of the range at 3,400 workshops under its Arena network. MSI had launched the Ecstar brand of engine oil at workshops under its premium outlet chain NEXA in September last year. The launch of Ecstar in Arena is a part of the company's focus on quality of maintenance while it continued to bring technology and quality into products. The Ecstar brand of engine oil and coolant and chemical products was launched by Maruti Suzuki's parent Suzuki Motor Corporation, Japan in 1984.

In 2015, it was promoted as a global brand and is currently marketed across Europe, USA, Mexico, Australia and South East Asia. The Ecstar range products includes engine oils, coolants, injector cleaner, automatic transmission oil, car care products, and screen wash for the cars. MSI said more products will be added to the ranged in India progressively.

Quaker® It's what's inside that counts.

HOUGHTON

Quaker Chemical Updates Timing on Houghton Integration

Quaker Chemical Corporation continues to be in productive discussions with the European Commission and Federal Trade Commission regarding its combination with Houghton International. Based on these discussions, Quaker said it continues to expect the remedy will involve a divestment of some product lines which, in total, are approximately 3% or less of the revenues of the combined company. This is consistent with Quaker's original projections and previous comments. Based on the information Quaker expects to receive approval from the regulatory authorities and close the combination in the fourth quarter of 2018.

Michael F. Barry, Chairman, Chief Executive Officer and President of Quaker said, "While the regulatory process is taking longer than expected, it is moving in the right direction with constructive discussions with both regulatory authorities. The additional time will allow us to finalize the process with the potential buyers and the regulators. We believe the end result will be a remedy that meets the needs of the market, the regulatory authorities, and the new combination."

Shell brings *Make the Future* **festival to India**

Team Averera of IIT-BHU with their vehicle

Shell is bringing their marquee event Shell Eco - marathon (SEM) to India for the first time. The SEM Challenger will be part of Make the Future India to be held in Chennai between 6th – 9th December 2018. Shell's Make the Future is a global platform for conversation, collaboration and innovation around the world's energy challenges. Shell Eco-marathon (SEM) challenges student teams around the world to design, build, test and drive ultra-energy-efficient vehicles. Applications for SEM open from 11th June 2018 to 28th August 2018.

SEM, which was first inaugurated in 1939, is the world's longest-running student competition wherein engineering students are challenged to design, build and test fuel-efficient cars. Indian teams have been partcipating since 2010 but this is the first time the competition will be held on home ground. With events hosted in countries around the globe, they aim to provide an opportunity for multiple stakeholders: including students, entrepreneurs, businesses, governments and the public, to experience, test and contribute bright energy ideas.

There has been a growing demand from colleges to bring the fuel-efficiency competition to India and this will allow widespread participation from students across the country. In the past, Indian students have showcased many innovative and energy efficient models and prototypes that has also caught attention of industry and government. Team Averera from IIT BHU created a light weight three-wheeled electric vehicle with customized motor controller, that clocked a mileage of 350 kms on a single litre of fuel.

Noria's 1st Public Training in Srilanka

Training on Essentials of Machinery Lubrication at Colombo, Srilanka

Essentials of Machinery Lubrication course provides the foundational skill sets for applying best lubrication practices and product knowledge. The three days Training was conducted in Colombo, Sri Lanka. Whilst Noria has conducted a few in-house trainings and LPD projects earlier, but this was its first public training in Srilanka. Looking at the response from the industry / participants, more such programs would be organised in future.

A similar program was also conducted in New Delhi (India) in June 2018. Several companies including Chevron, Camso Loadstar, Siam City Cement, Lanka IOC, JK Tyre, GKN Driveline, Hindustan Petroleum, Indian Oil Corporation, Ultratech Cement, Heromotocorp, Total Oil and Bechem India etc participated.. Participants learned proven industry methods for selecting, storing, filtering and testing lubricants to boost reliability and generate lasting results in machine efficiency/ maintenance through these trainings.

Essentials of Machinery Lubrication training in New Delhi

Training on Oil Analysis Fundamentals in Mumbai

A three days Training on Oil Analysis Fundamentals conducted in Mumbai in June 2018. The companies participated were Indian Oil Corporation, Hindustan Petroleum Corporation Refinery, Mangalore Refinery and Petrochemicals Ltd. etc The training was a great success as the participants enhanced their knowledge on Oil Sampling, Lubricant health monitoring, contamination measurement and control and wear debris monitoring. Oil Analysis Fundamentals also covers topics like lubricant selection, troubleshooting, predictive maintenance and more. In addition to learning the right metrics for program implementation and evaluation, participants got a view on the most advanced levels of diagnostics and predictive maintenance.

ICML Certification exam was also conducted at all the locations, where majority of the participants joined the elite group of certified professionals.

UPCOMING EVENTS AUGUST - SEPTEMBER 2018

AUGUST 01st - 02nd
2nd AMEA Base Oil, Lubricant and Wax (BLW) Conferences
Mumbai, India

AUGUST 22nd - 23rd
ACI US Base Oils and Lubricants Summit
Iowa, USA

SEPTEMBER 10th - 11th
BFPA International Conference on Managing Fluid and Lubricant Contamination
Bath, United Kingdom

SEPTEMBER 17th - 19th
SAE International Powertrains, Fuels and Lubricants Meeting
Heidelberg, Germany

SEPTEMBER 19th - 20th
ICIS/ELGI North American Industrial Lubricants Congress
Chicago, USA

BASE OIL REPORT

Oil markets have shown tremendous weakness in recent days. What's causing it? Market analysts have been struggling to find a single reason for it, preferring to cite a cocktail of negative news and rumor to explain the downdraft.

There have been reports of increased Saudi production to Asian customers, which many cite as a breaking of the dam of OPEC production guidelines – a break that would have many in the oil world in full panic mode.

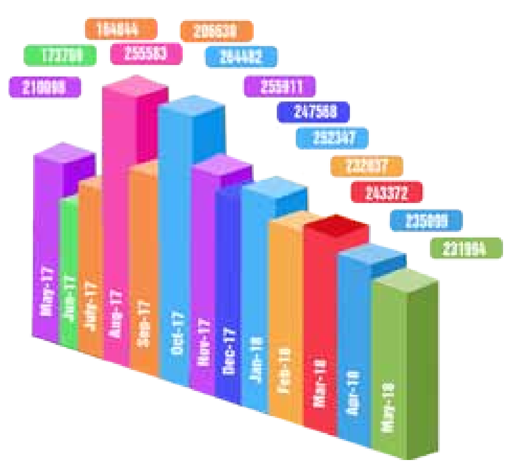
The Asian contracts are merely adding stability to the oil markets in front of the threats of renewed U.S. sanctions on Iran. The announcement that China and India are considering forming an "Oil Buyers Club" to counter the market power of the Organization of Petroleum Exporting Countries is proof that the run-up in oil prices this year, from $30 a barrel to $80, is happening in a very different context than spikes of the past. The proposed alternative to OPEC could be good news for importing nations' economies and the environment.

As per the data analysis by our team, import of the country has gone up by 22% during Jan to May 2018, as compared to same period last year i.e. Jan to May 2017. Compared to last month i.e. April 2018, import of the country has decreased by 1% in the month of May 2018. India import has gone up by 10% in May 2018, as compared to same period last year i.e. May 2017.

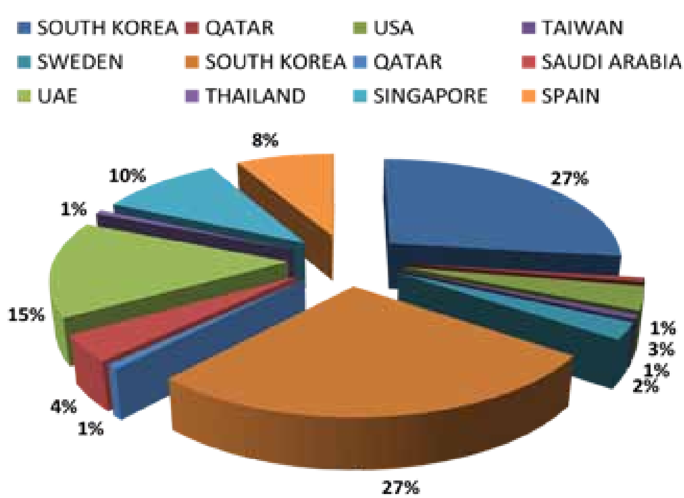
In the month of May 2018, India imported 231994 MT of Base Oil, India imported the huge quantum in small shipments on different ports like 120632 MT (52%) into Mumbai, 35415 MT (15%) into JNPT, 30473 MT (13%) into Chennai, 17046 MT (7%) into Kandla, 8346 MT (4%) into Pipavav, 7600 MT (3%) into Hazira, 4909 MT (2%) into Kolkata, 3863 MT (2%) into Mundra, 2090 MT (1%) into Ennore, 1318 MT (1%) into Delhi and 302 MT into Tuticorin.

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 input to India, Country and %- May 2018



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

Month	Group I - SN 500 Iran Origin Base Oil CFR India Prices	Group II -J-150 Singapore Origin Base Oil CFR India Prices	N- 70 South Korea Origin Base Oil CFR India Prices	Rubber Process Oil Drums Iran Origin CFR India Prices
May 2018	USD 850 – 860 PMT	USD 825 – 840 PMT	USD 785 - 795 PMT	USD 500 – 510 PMT
June 2018	USD 840 – 850 PMT	USD 815 – 830 PMT	USD 775 - 785 PMT	USD 490 - 500 PMT
July 2018	USD 840 – 850 PMT	USD 815 - 830 PMT	USD 775 - 785 PMT	USD 490 - 500 PMT
	Since January 2018, prices have gone up by USD 60 PMT (8%) in July 2018.	Since January 2018, prices have gone up by USD 50 PMT (6%) in July 2018.	Since January 2018, prices have gone up by USD 67 PMT (9%) in July 2018.	Since January 2018, prices have hike up by USD 35 PMT (8%) in July 2018