Machinery Lubrication

India July-August 2015

www.machinerylubricationindia.com

INSIDE

Lubrication – OFF Highway Mining Equipments

If you're thinking productivity, upgrade to a smarter grease.

All greases are not created equal. In fact, ours are engineered to be smarter right from the start. With an advanced formulation designed to provide all-round, balanced performance for the severe conditions experienced by today's equipment.

What's more, our high-technology greases offer a controlled release of oil and additives. They know just the right amount to release, lubricating for extended protection. Providing greases that stick better – so they stay exactly where they're needed – making them easier to use, helping reduce maintenance and replacement costs. Adding up to greater productivity. Learn more about our advanced engineered greases for advanced productivity at **mobilindustrial.com.**

Mobil Grease™

Performance by ExxonMobil

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Machinery Lubrication India
July-August 2015

Publisher's Note

India remained the third-largest producer of coal in FY14 and ranks fifth worldwide for its coal reserves in the field of metals and mining, as this issue is focused on. By the end of this year, the country is expected to become the second-largest steel producer. According to a FICCI report, the nation remains strong in its natural mineral resources.

The critical phase the Indian mining industry passed through in the last few years has been strengthened through Governmental policy issues for mines of all sizes – small, or medium or large. For example, a large number of small miners are not able to purchase state-of-the-art mining equipment, the requisite fuel and maintenance fuel for those and employ the right personnel.

At the same time, small scale mining contributes 6% to the cost of mineral production. Overall capabilities continue to be surveyed and prospected by national bodies such as the Geological Survey of India (GSI), Central Mine Planning & Design Institute (CMPDI), Mineral Exploration Corporation Limited (MECL), National Mineral Development Corporation (NMDC) and Indian Bureau of Mines (IBM). Oil and Natural Gas Corporation (ONGC) is India's premier Public Sector Undertaking responsible for majority of India's crude oil and natural gas production.

This issue of Machinery Lubrication India details the contribution of the segment to overall industry and mentions types of equipment and maintenance measures for that equipment for the mining sector. Your magazine deals with environmental conditions to be considered for lubrication in mining and equipments and the nature of mining gearboxes.

Individual mines will have mining equipment requirements and strategies to meet those requirements in place. Every mining unit speaks of the ore type and management concerns of its own with individualized planning and operational inputs for condition monitoring systems for mining and quarry plants. As exists in all industrial sectors, oil analysis can help improve reliability.

Our third industry specific issue of Machinery Lubrication India in 2015 also celebrates its partnership on Lubrication with the Confederation of Indian Industry (CII) on July 17 at Vadodara. For the next issue, we continue to welcome written participation from others in the field of Industrial lubrication.

Warm Regards,

Udey Dhir

Wes Cash | Noria Corporation

The HARD TRUTH About Particle CONTAMINATION

It has been proven that the No. 1 cause of machine failure is the degradation of component surfaces. These surfaces can degrade in a variety of ways, but the most destructive is via particle contamination. While you may already be aware that dirt is harder than most metals found in machines, do you know how much harder it is?

Before analyzing the differences in the hardness of materials, you must first understand how hardness is measured. A quick Internet search for hardness measurements likely would yield three general methods: Rockwell hardness, Vickers hardness and Mohs hardness. Although each of these tests is a little different, they all measure a material's strength by indenting or scratching.

Rockwell Hardness

The Rockwell hardness test method has several scales that are based on the tester's indenting tip. However, they all work similarly. A load is applied to the indenter, which then transfers the load to the material being tested. At the conclusion of the test, the indention depth is measured. Most metals are tested using the "C" scale, which employs a diamond tip to aid in the indenting process. The higher the number in the Rockwell scale, the harder the substance.

Particles of high compressive strength (hardness) and angularity (sharp edges) cause the greatest damage.

Vickers Hardness

Like the Rockwell scale, the Vickers hardness test uses a diamond tip and relies on indenting a surface to measure how hard it is. The higher the value, the harder the material. However, the measurement is a little different. While the Rockwell scale measures the indention depth, the Vickers test involves locating the indention and comparing it with the force required to achieve it. Once this ratio is determined, you are left with a measurement of the material's hardness.

Mohs Hardness

The Mohs hardness scale is a much older method used primarily by jewelers and those who are concerned with minerals. It was based on a scale of 1 to 10, with diamond being at the top (the 10 value). Materials were tested against each other, and if one scratched the other, it would be given a higher value. For instance, gypsum can scratch talc; therefore, gypsum would have a higher Mohs value than talc. Since diamond scratches everything, it was given the highest value.

The Mohs scale is easy to interpret, but it lacks the certainty of the other tests. The difference between a 5 and a 6 on the Mohs scale cannot truly be determined, whereas the hardness differences on the Rockwell and Vickers scales are much more tangible.

Applications

Most bearings are created using a type of chrome steel. Although there are many variations of this material, the majority come in at approximately 60 on the Rockwell hardness scale (848 on the Vickers hardness scale). In contrast, quartz has a Vickers hardness of approximately 1,200 (7 on the Mohs scale), which is roughly 1.5 times harder than chrome steel. Quartz was chosen for comparison because it is one of the most abundant minerals in soil (primarily sand). Silica-dioxide crystals are commonly referred to as quartz and can be found in most soils. Soils can vary from region to region, with some more abrasive than others. For example, the soil around my house

PARTICLE TYPE	SOURCE	TYPICAL SPECIFIC GRAVITY	MOHS HARDNESS*	GENERAL APPEARANCE
Burrs and machining swarf	B	6 – 9	3 - 7	Curls, spirals
Grindings	B,I	6 – 9	3 - 7	Curls, chunks, chips
Abrasives	B,I	3 – 6	7 - 9	Sharp-edged chips
Floor dust	B,I	1 - 5	2 - 8	Chips, flakes, chunks
Road Dust (mostly silica)	I	2 - 6	2 - 8	Rounded chunks
Mill scale	I	5	NA	Flakes, tree bark appearance
Coal dust	I	1.3 – 1.5	NA	Black, shiny flakes
Ore dust	I	Various	Various	Irregular-shaped chunks
Wood Pulp	I	0.1 – 1.3	1.5 - 3	Fibrous
RR ballast dust (limestone)	I	2.68 – 2.8	5 – 9	Chips and chunks
Quarry dust (limestone)	I	2.68 – 2.8	5 – 9	Chips and chunks
Foundry dust	I	2.65	7	Chips and chunks
Fibers	I, G, B	Various	Various	Fibrous
Slag particles (blast furnace)	I, G, B	2.65	7	Silica, sharp edges, vitreous
Aluminum oxides	I, G, B	NA	9	Crystals, colorless
Red iron oxides (rust)	I, G, B	2.4 – 3.6	5 – 6	Red-orange crystals
Black iron oxides (magnitite)	I, G, B	4 – 5.2	5 – 6	Black/bluish chunks
Copper oxides	G, B	6.4	3.5 – 4	Small, shapeless
Tool steel	G, B	7 – 8	6 – 7	Various shapes
Forged steel	G, B	7 – 8	4 – 5	Various shapes
Cast iron	G, B	6.7 – 7.9	3 – 5	Granular or flake-like
Mild steel	G, B	7 – 8	3	Various shapes
Alloys of copper, bronze	G, B	7.4 – 8.9	1 – 4	Various shapes
Alloys of aluminum	G, B	2.5 – 3	1 – 3	Various shapes
Babbitt particles	G	7.5 – 10.5	1	Various shapes, gray
Soot	G	1.7 – 2.0	NA	Vitreous, brown or black

INGRESSION SOURCES

B =	Built in during manufacture or repair
I =	Ingested from the atmosphere
G =	Generated from within the machine
NA =	Not available

***MOHS HARDNESS SCALE**

Scale 1-10

Diamond = 10

Fingernail = 1

Machines susceptible to dirt ingression should be outfitted with devices to prevent these particles from getting inside the equipment.

in Oklahoma is classified as clay loam. This is a common soil type that has a blend of different levels of sand, clay, silt, etc. While other minerals in dirt can be abrasive, it is the silica that cuts the most. In areas with high concentrations of sand in the soil, it is important that machines susceptible to dirt ingression are outfitted with devices to prevent these particles from getting inside the equipment.

Hopefully, you now have a better understanding of just how much harder dirt is than bearing and gear surfaces. Considering that steel has a Mohs value of only 4.5, the old adage "tougher than nails" doesn't sound quite as impressive and perhaps should be changed to "tougher than dirt." ■

Machinery Lubrication India

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Rider House, 136,
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National Capital Region, India

Machinery Lubrication India Volume 20 - Issue 3, July-August 2015 is published bi-monthly by VAS Tribology Solutions Pvt. Ltd. Operation Office:213, Ashiana Centre, Adityapur, Jamshedpur-831013, India.

SUBSCRIBER SERVICES: The publisher reserves the right to accept or reject any subscription. Send subscription orders, change of address and all related correspondence to: VAS Tribology Solutions Pvt. Ltd. Operation Office:213, Ashiana Centre, Adityapur, Jamshedpur-831013, India.

SAMRAT DAS, Indian Oil Corporation Limited

Lubrication - OFF Highway Mining Equipments - A Perspective

MINING – PAST & PRESENT

Mine production has undergone important changes during the 20th century with a shift from underground to open pit mining techniques. Early in the century, underground mining dominated in developed countries, and as mining evolved in emerging economies, open-pit mining became more common.

Surface mining is a very old practice. In North America, for example, mining for copper at the surface of the Michigan Upper Peninsula appears to have started as early as 5000 B.C. The ore produced through the hard labor of thousands of miners went to the manufacture of hand tools and jewelry.

There is much evidence that suggest that mining of coal; iron-ore, copper; lead-zinc has been going on in this country from the time immemorial. However, the first recorded history of mining in India dates back to 1774 when an English Company was granted permission by the East India Company for mining coal in Raniganj. In India, 80% of mining is in coal and the balance 20% in other minerals, totaling 89.

Mining equipment has evolved into some of the most fascinating functional mechanical structures known to man. Today while the worldwide market for mining equipment is around US $ 100 Billion, India's market is only around US $ 1 Billion (or 1 %). But it will change dramatically over the next few decades as mining activities are expected to pick up rapidly from here given the humungous appetite for power in India and the GOI push to infrastructure sectors like cement, steel etc.

TODAY'S MINING EQUIPMENT – ARE THEY LARGE ?

India produces about 90% of Coal from open cast mining. Open cast mines deploy large number of state of the art Heavy Earth Moving Machines like Draglines, Shovels, Dumpers etc. Draglines are the largest mobile equipment in the earth which remains the choice wherever geo-mining condition permits because of their high production versatility and low cost per unit moved.

The Caterpillar 797 is the largest dump truck built till date. They stand 23 feet 9 inches tall when the dump bodies are down, and 49 feet 3 inches when they're tilted up. But most gym floors aren't reinforced to withstand their 560,000-pound weight when empty, much less the 1,280,000-pound total when burdened with 360 tons of rocks and dirt. The mining roads they operate on, for instance, must be three times the width of the widest truck running on them, and the service shops often need enlarging and re-equipping.

The CAT 797 & other similar dump trucks are this big because the machines built to tear open the earth have grown ever larger. When the world's biggest shovels were grabbing the planet in

60-ton scoops, the trucks built to haul stuff away were rated at four shovels full. Now shovels such as RH 400, EX8000 etc. are in the 90-to-100-ton range, and efficient mine owners need trucks that swallow 360 to 400 tons per load. Thus when shovels grow again, so will the trucks.

MINING SECTOR – CHALLENGES

The mining sector faces a host of industry challenges, including fluctuating commodity prices, slimming margins, and increasing expectations from shareholders and national governments (i.e. CSR activities, environment upkeep etc.).

According to a 2014 report, these factors have driven mining companies to focus on production volume above all else, which in turn has led to an even greater industry challenge—maintaining productivity levels. In recent years, productivity growth in the mining sector has been on the decline, and addressing this issue is at the top of almost every mining executive's agenda.

According to the report, implementing best-in-class maintenance practices can be the difference between achieving acceptable equipment availability rates of 85% and achieving industry-leading availability rates of more than 90%. There are a range of services available to mine operators that can arm them with the right information when it comes to improving equipment maintenance and performance.

To maximize profitability, mining companies are undergoing major initiatives to monitor and control those factors that can impact production. One of the significant contributors to both operational cost and production capacity involves the heavy mining equipment that keeps the ore moving every day. The operating and maintenance costs of mining equipment not only represent a large proportion of a mine's operational expenditures but they also threaten a mine's profitability.

A truck that is taken offline for a shift has a big financial production impact, but for a shovel, the impact can be many times that. In addition, the ability to extend the operating life of the very costly haul truck or a shovel is significant with respect to the success of a mine.

FOCUSING ON "LUBRICATION COST" AND NOT THE LUBRICANT COST

In today's off-highway equipment world, the driving force in new product development is to enable end users to have lower operating costs. Equipment manufacturers have responded by increasing equipment efficiency, primarily by increasing equipment size, increasing the load carrying capacity and operating speeds while constantly striving to reduce both equipment

cost and weight. Increasing equipment size has triggered the increase in the engine's size and horsepower, which in turn has placed more demand on the drivetrain hardware components (i.e. transmission, axles, hydraulics and gears) and correspondingly on the fluids that lubricate these components and keep this equipment running optimally for their expected useful life cycle.

Typically, there have been increases in power, power density and torque with each successive model. This increase in power density generates more heat, raising oil sump temperatures throughout the drivetrain. Transmissions, differentials and final drives are subjected to increasingly higher loads as machines become capable of shifting larger quantities of material and much faster. The surface finish of components, their design and metallurgy have steadily improved but they still require the highest level of lubrication to deliver maximum performance and remain durable.

Lubricant manufacturers have developed specialized engine oils, transmission and drivetrain oils to provide the appropriate level of performance. Over the past few years, Indian lubricant manufacturers have developed specialized power transmission fluids designed to provide the appropriate level of performance required to meet stringent OEM specifications. Higher operating temperatures coupled with higher load factors has driven the development of new oils with increased wear protection, enhanced friction performance, in addition to a number of other performance attributes.

Power transmission fluids (in SAE 10W , 30 & 50) are specially designed heavy duty transmission fluid for off-highway power shift and certain non-synchronized manual transmissions, wet brakes, final drives and hydraulic systems meeting the rigorous performance requirements of Caterpillar TO-4, Allison C-4 and other off-road equipment specifications. It contains carefully selected base oils assuring the up most oxidation, thermal and shear stability for long oil life while the specialized additive system provides additional oxidation resistance, balanced frictional performance, wear protection and maximum power transfer during operation. They also contains additional special additives to enhance cold temperature performance, rust, corrosion, and foam protection, along with outstanding compatibility of clutch friction material and seals. The use of such dedicated driveline fluids brings in huge benefits in terms of increased performance and massively increased protection. There are also the final drive axle oils (FDAO) and synthetic gear oils which are available in the Indian market.

For shovels, hydraulic oils are now available from Indian lube marketing companies which can increase productivity and even help in reduced fuel consumption leading to substantiate savings for the users. Long drain hydraulic oils are also available which can provide 50%-100% increase in the oil drain interval (ODI). All such oils have passed the tests during various field trials conducted in Indian conditions.

In engine oils selection, the mining industry needs to move from the API CH4, CI4, CI4 Plus to the CJ4 grades in SAE 15w40 viscometrics. To increase fuel economy, some users contemplate using lower viscometrics like 5w30 etc., but many OEMs have their reservation w.r.t. engine durability.

Extending oil drain intervals in off-highway engines and machines can be challenging though. Dirt ingress and coolant leaks occur more frequently, and at times oil drain intervals are established to minimize damage from such problems. The cost reduction associated with longer oil and filter change intervals must be balanced against the risk of shortened engine life and the cost associated with less reliability if oil drain intervals are extended too far.

Thus correct fluid and adherence to proper lubrication regimes is important not only to achieve higher productivity but also to reduce cost of repairs and downtime. Using the correct specialized fluid undoubtedly can cost more, but that cost is still insignificant when compared to the cost of the equipment, repairs and lost revenue in downtime. Low-price generic fluids are not robust enough, nor do they have the correct specifications to protect gear and transmissions components in

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high performance and heavy machinery operating in hostile conditions.

Given the use of the correct lubricant, maintaining fluid integrity is still an important consideration. Machines are usually working in dusty conditions so filter condition must be maintained properly to achieve extended equipment life.

As an alternative to manual lubrication, automatic lube-delivery technologies have been introduced specifically for machinery in the off-highway marketplace. In particular, automatic centralized lubrication systems in different configurations have gained significant ground by enabling the right lubricant to be supplied at the right time and at the right lubrication point -- without manual intervention. The size of a machine, type of required lubricant, number of lubrication points and other factors will guide initially in choosing the most viable centralized lubrication system for an application. The primary purpose is to supply lubrication points continuously with metered lubricant while the machinery is in operation and all the bearings are moving.

CONDITION BASED MONITORING

With escalating operating costs, mining companies need to constantly monitor the performance of their heavy mobile equipment. Profitability depends on having the means to accurately diagnose any performance issues before they lead to production downtime.

Equipment maintenance costs represent between 30% and 50% of direct mining expenditures. Most often mining companies employ traditional preventative and reactive maintenance programs for critical equipment, which take up the majority of the maintenance people time.

New advancements in equipment monitoring technology enable time constrained technicians and engineers to discover, diagnose and act on a fault before it results in production downtime or serious damage to the equipment or operator. By remotely accessing onboard equipment data, personnel can immediately view and analyze equipment and operator performance through a variety of dashboards, user defined key performance indicators and alarms, to facilitate immediate action.

While equipment monitoring is not new to the mining industry, traditional methods, unstable technology and the extreme mining conditions have; often plagued the effectiveness of these first generation solutions.

Maintenance personnel can now monitor the entire mining fleet and receive early warnings of developing problems, prompting action and reducing negative impact on operations. Ultimately, vital equipment spends less time on the shop floor and more time in the mining field.

Similarly, it is always suggested that maintenance personal take advice and support from lube marketing companies to get their oil analysis and trends monitoring done for each individual equipment. Such expertise in Condition Based Monitoring (CBM) and Total Fluid Management (TFM) services is now available to the users in the Indian context. It's important for mine companies to partner with lubricant suppliers that are able to understand and account for the diverse needs of an operation.

CONCLUSION

In a mine, you are constantly striving to maximize machine availability and drive down your production and maintenance costs in tough conditions and in remote areas. Mining tools have evolved into massive machines. Greatly increased component sizes and load limits have placed tremendous responsibility on the machinery designer and the lubricant system manufacturer, to design and engineer systems that can be counted on to effectively lubricate and sustain these machines. Effective lubrication of these heavily loaded components is absolutely critical to efficient, reliable, economical operation of a mine site. Choosing the right lubricants and services for your needs can help to make a real difference to your bottom line.

About the Author

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OEE- Overall Equipment Effectiveness

Industrial Lubricants improve productivity under company technology leadership and application expertise. But what is really meant by "improving productivity"? How can productivity be defined? For years the company has talked about lower total cost of ownership, reducing unscheduled downtime and improving maintenance practices, but how do those concepts impact a customer's productivity, and in turn, profitability? Do they really matter?

One prevailing industry measure of productivity is Overall Equipment Effectiveness, OEE. Simply stated OEE is a measure of the productivity of an asset. If a machine has a planned production of 10 hours, with the expectation that it can produce 8000 units during that time, but the machine only produces 6300 units during the shift, that machine has an OEE of 79% (6300 / 8000 = .7875). But what does that mean, and how can Industrial Lubricants help increase that number?

The components of OEE

To answer this question, you must understand the three components that make up OEE. hese components are defined as Availability, Performance, and Quality. These three dimensions are measured individually and combined to create a total OEE.

Availability measures how frequently a machine is available for its intended use. Events that stop a machine's production result in a down time loss. Availability can be affected by equipment failure, unplanned maintenance and downtime, material shortages, and machine changeover times.

Performance is more difficult to assess, but is defined as a speed loss. If a machine is rated to produce a certain amount of units per hour, and runs uninterrupted for that hour, producing fewer units than the machine's rating is defined

as a performance loss. These losses can be attributed to machine wear, operator inefficiency, substandard materials, or material misfeeds.

Quality is probably the easiest of the three components to quantify. Quality can be calculated simply by measuring the amount of scrap a machine produces. Any reject material, pieces that don't meet quality standards, and rework all contribute to quality losses.

Measuring OEE

Now that we understand OEE, we need to be able to measure it to track improvements. Availability is computed as a ratio between actual operating time and planned production time.

$$\text{Availability} = \frac{\text{Operating Time}}{\text{Planned Production Time}}$$

Performance is the ratio of the ideal cycle time to the operating time divided by total pieces produced.

$$\text{Performance} = \frac{\text{Ideal Cycle Time}}{(\text{Operating Time} / \text{Total Pieces produced})}$$

This can also be defined as a ratio of Net Operating Time to Operating Time.

Quality is measured as the ratio of good pieces to Total pieces

$$\text{Quality} = \frac{\text{Good Pieces}}{\text{Total Pieces}}$$

OEE Example

Here is an example of an OEE Calculation, based on the information one operator may record.

The plant shift is 8 hours, with two planned 15 minute breaks and a 30 minute meal break. The injection molder in question can produce 30 pieces per minutes at its ideal cycle time. The machine is down for 38 minutes of the shift, but produces 9,723 pieces during its uptime. 207 of these are rejected and sent for regrinding. Just based on this information we can calculate OEE...

8 hours	480 minutes
Breaks	60 minutes
Downtime	38 minutes
Parts Produced	9723
Rejects	207
Rating (pieces per minute)	30
Planned Production Time	480 - 60 = 420
Operating Time	420 - 38 = 382
Availability	382 / 420 = 0.910
Performance	(9723 / 382) / 30 = 0.848
Good Pieces Produced	9723 - 207 = 9516
Quality	9516 / 9723 = 0.979
OEE	0.910*0.848*0.979=75.5%

This machine had an OEE of 75.5% this shift

How Mobil Industrial can help improve OEE

Many of the areas Mobil Industrial Lubricants has focused on for years are also key drivers of improving OEE. We know that higher quality lubricants can lead to lower total cost of ownership by reducing unscheduled downtime, increasing machine and component life and extending maintenance intervals.

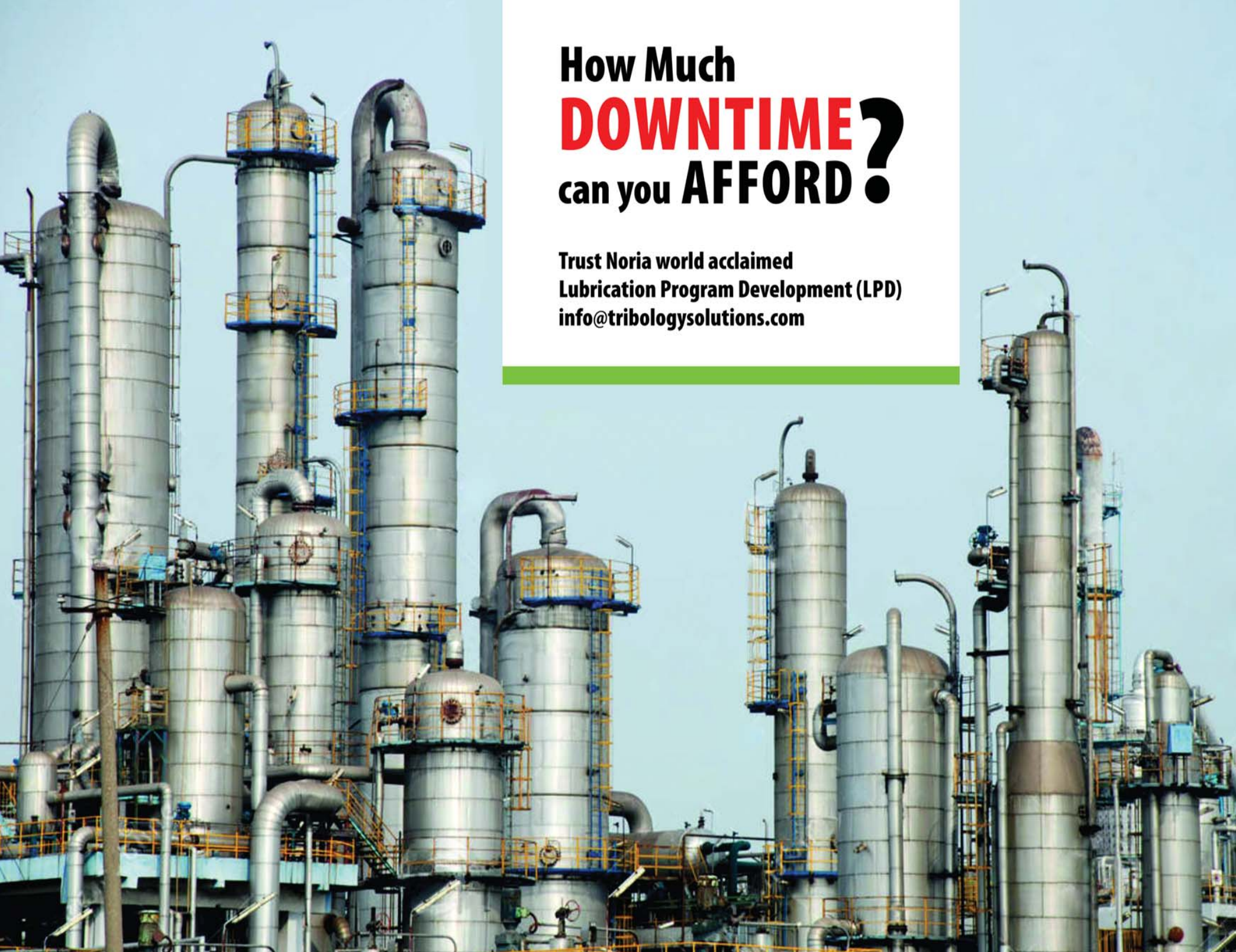
Let's look at how these can drive higher OEE. In an injection molding machine, a malfunctioning servo valve can cause an unscheduled machine shutdown, and cost up to a half hour of machine availability. A blower breakdown can create difficulties getting raw materials into the machine hopper, interrupting production. Unplanned events such as these drive down machine availability, and correspondingly, OEE. By using Mobil Industrial Lubricants and an oil analysis program, you can reduce equipment failures and better predict service life, allowing you to increase your machine's availability.

You can also drive performance by uUsing sing high quality lubricants and maintenance practices. A hydraulic system that has pump wear, deposits, and varnish will not operate at its rated performance level, with decreasing speed and pressure as a result. Mobil premium hydraulic oils have been proven to offer outstanding contamination control, exceptional wear protection, and cleanliness that lasts. These critical characteristics, combined with monitoring the system with an oil analysis program can help keep your machines performing at their highest level.

Quality can also be directly impacted by the lubricants in use. Malfunctioning ejector pins can cause parts to stick inside the mold, sending them to the scrap heap for regrinding. Poor hydraulic clamping pressure can have the same effect. All of these losses can mount, seriously impacting overall productivity. Using Mobil SHC grease can reduce ejector pin wear, reducing your quality losses.

About the Author

Shankar Karnik joined Indo Mobil Pvt Ltd Industrials in 1998. Following its merger with Exxon, he was appointed Business Development Manager – Power. He developed the Industrial lubricants business, going on to oversee the North & West India markets, with the marine lubricants business added. Karnik is currently General Manager, Industrial at ExxonMobil Lubricants Pvt Ltd.



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Using Ultrasound TO IMPROVE Lubrication PRACTICES

By Adrian Messer, UE Systems

Keeping a handle on lubrication seems easy enough. All you need to do is to make sure the right lubricant is used in the right amount and at the right time. Unfortunately, it's not that simple.

It has been estimated that 60 to 90 percent of all bearing failures are lubrication related. Bearing failures most often lead to unplanned downtime, which can impact production as well as affect all related components around the bearing. Downtime is costly. While the cost varies by incident and by plant, it can add up.

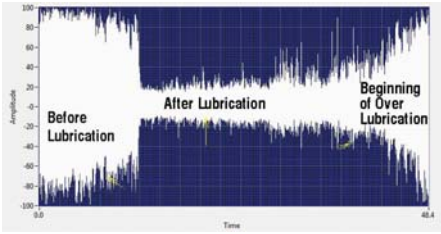
As the most common cause of bearing failure, lubrication is serious business. For many years, this "serious business" has been conducted in a way that makes perfect sense on the surface but in fact borders on being haphazard.

Many technicians have relied on preventive, time-based lubrication alone. That is, every "X" number of months, the grease gun comes out, and the bearings are lubricated. After all, underlubrication can be lethal, causing equipment failure, costly repairs and replacements, significant unplanned downtime, and lost profits. But by relying solely on time-based lubrication, or even a combination of planned maintenance and temperature readings to serve as a proxy for lubrication status, you run the risk of something just as bad if not worse — overlubrication.

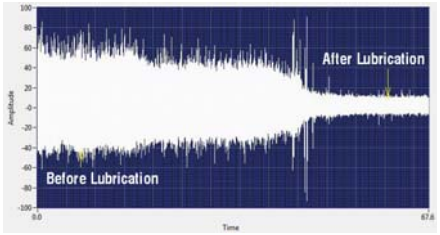
Relying on time-based, periodic lubrication assumes bearings need to be greased at defined time periods. Often this evolves into a well-intentioned guessing game at best. Adding more lubrication to a bearing that is already adequately greased is a real risk.

By using ultrasound technology (along with normal practices such as removing old grease and replacing it with new), technicians can combine standard time-based maintenance with condition-based predictive maintenance, gaining in the process both a clearer picture of what's really going on in their machines and improved reliability.

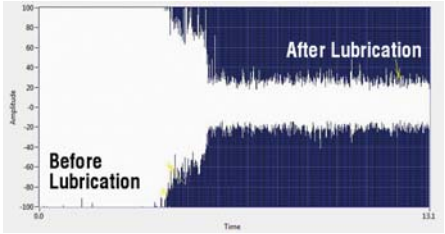

CAUTION



This image shows what happens when too much lubricant is applied. Notice the increase in amplitude or the noise level when lubricant continues to be applied.



This is another time series view of a recorded ultrasound from a bearing in the process of being lubricated.



The image above is a time series view of a recorded ultrasound from a bearing in the process of being lubricated. Notice the before noise or amplitude at the beginning and then once the bearing was properly lubricated at the end.

How Ultrasound Works

Ultrasonic equipment detects airborne and structure-borne ultrasounds normally inaudible to the human ear and electronically "transposes" them into audible signals, which a technician can hear through headphones and view as decibel (dB) levels on a display panel. In some instruments, the received sound can also be viewed on a spectral analysis screen. With this information, a trained technician can interpret the bearing condition in order to determine what, if any, corrective action is needed.

Ultrasound technology has many advantages:

- It can be used in virtually any environment.
- Learning to use it is relatively simple.
- The technology is fairly inexpensive.
- Modern ultrasonic equipment makes it easy to track trends and store historical data.
- Ultrasonic technology has proven to be extremely reliable in predictive maintenance, saving thousands of dollars and hours of lost productivity.

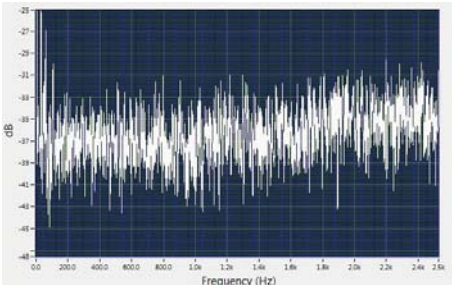
Airborne and structure-borne ultrasound instruments are an extension of the user's sense of hearing. Just like vibration feels what you can't feel and infrared cameras see what you can't see, ultrasound hears what you can't hear. Noise in a typical plant environment (machines running, production equipment running, etc.) can prevent you from being able to hear other sounds such as compressed air leaks or electrical discharges like corona, tracking or arcing.

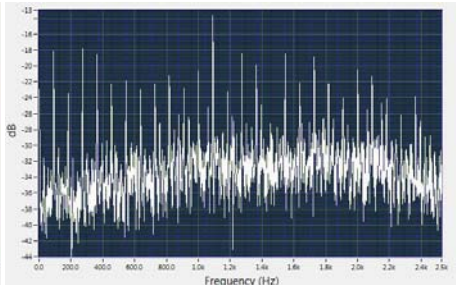
Ultrasound instruments sense or listen for high-frequency sounds that are not heard in the audible range by normal human hearing. These high-frequency sounds are detected by the instrument and translated into an audible sound that is heard in the headset by the inspector. The decibel level is then indicated on the instrument's display.

Condition Monitoring and Ultrasound

Traditional inspection of electrical components has been performed using an infrared camera. Users of this technology rely on images showing temperature changes that may represent electrical anomalies such as tracking and arcing. For mechanical inspection, vibration analysis has been the conventional method for condition monitoring of rotating equipment. Vibration analysis produces a visual spectrum or time waveform that reveals any fault harmonics. If the goal is to have a truly world-class predictive maintenance (PdM) program, the use of multiple technologies is recommended for various inspections. Just as a physician uses multiple tools to diagnose aches, pains and abnormalities, maintenance professionals should take the same approach when it comes to the assets they are responsible for in their facilities.

In addition to infrared and vibration, ultrasound can be used to complement other PdM technologies. Airborne and structure-borne ultrasound can give the user an "image" to analyze in order to diagnose and confirm mechanical and electrical conditions. The concept of ultrasound imaging involves recording sounds heard via the ultrasound instrument and then playing back those recorded sounds in spectrum analysis software. This can provide the inspector with the audible sound heard in the field during the inspection and a visual "image" or spectrum of the recorded ultrasound. This method can help to reduce the





subjectivity of only relying on changes in the decibel level and in the sound tone or quality heard by the inspector.

How Ultrasound Produces Better Lubrication Practices

Ultrasonic technology helps the lube tech take a lot of the guesswork out of lubrication. Ultrasound is a localized signal, which means that when a sensing probe is applied to a bearing, it will not be affected by "crosstalk" and will allow the technician to hear and monitor the condition of each bearing. Ultrasound looks at each bearing individually, much the same way medical ultrasound can detect exactly which artery is clogged or which vein is leaking.

How does ultrasound work in regard to lubrication? The first step is to establish both a baseline decibel level and a sound sample. This is ideally done when moving through a route for the first time by comparing dB levels and sound qualities of similar bearings. Anomalies will be easily identified. Once baselines are established, each bearing can be trended over time for any changes in either amplitude or sound quality.

Generally speaking, when the amplitude of a bearing exceeds 8 dB and there is no difference in the sound quality established at the baseline, the bearing needs to be lubricated. To prevent overlubrication, the technician should apply the proper lubricant a little at a time until the dB level drops.

Many organizations set up their condition-based lubrication programs by incorporating a two-stage approach. The reliability inspector uses a relatively sophisticated ultrasound instrument to monitor and trend bearings. A report of bearings in need of lubrication is produced. The lube tech then uses a specialized ultrasound instrument that alerts the tech when to stop adding grease.

To improve efficiencies, it is good practice for the technician to note when the equipment was last greased and how much grease was applied in

order to calculate roughly how much lubricant is used per week. By utilizing ultrasound to lubricate each and every time, the technician produces historical data that can be employed as a guide to help determine whether the lubrication schedule can be modified to save man-hours and if the manufacturer's suggested lubricant amount is accurate. If less is needed, there's cost-saving potential.

While most of this article has focused on the dangers of underlubrication and overlubrication, ultrasound is just as reliable in picking up other potential bearing failure conditions. A technician using ultrasound can hear telltale "grinding" sounds and other anomalies, which are often accompanied by an amplitude increase. In regard to lubrication, the advantage of ultrasound is that it is able to isolate bearings and determine their individual needs, thus reducing the possibility that some bearings are too "dry" and preventing others from overlubrication.

Why Use Ultrasound?

It is always a daunting proposition to make a new investment in technology. Will it pay off? Will your staff actually have an easy time using it? Is it a flash in the pan or a truly reliable modality that will stand the test of time?

Although more plants are utilizing ultrasound and adopting a predictive or proactive approach rather than a reactive mindset, there are still many that are figuratively using crystal balls and outdated methodologies. The end result is poor reliability, unnecessary man-hours, downtime, and lost productivity and profit. While ultrasound can't cure all reliability ills, it has proven itself in a wide variety of settings to be a valuable and powerful diagnostic tool that technicians should add to their toolkits.

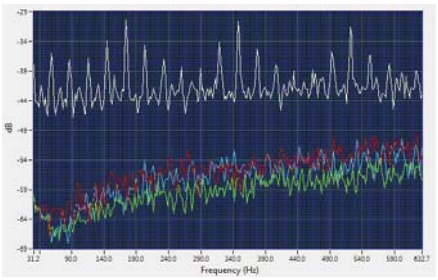
When it comes to something as important to reliability as lubrication, the real question becomes, "Can you afford not to use ultrasound technology?" Consider the plant that went from almost 30 bearing failures a year before using ultrasound to having no bearing failures for three years once ultrasound was added to its maintenance arsenal. It's no coincidence. Ultrasound works.

Using an ultrasound instrument while greasing allows technicians to know when they have added enough grease or when too much grease has been applied.

Ultrasound-assisted Lubrication

When it comes to lubrication practices in plants, there are three scenarios that could be considered as good, better and best. A good scenario would be to follow the manufacturer's recommendations as to the frequency, type of lubricant and amount of lubricant to be applied to a certain piece of equipment. A better scenario would be to still make use of the timed interval, but instead of lubricating with just a grease gun, utilize an ultrasound instrument while greasing. This will at least allow the lube techs to know when they have added enough grease or when too much grease has been applied. Another benefit is that the individual lubricating the equipment can listen to the bearing while greasing it. This enables the inspector to hear if other bearing defects are present that lubrication may not help. In a sense, the lubricators become fault finders. If a bearing does not sound normal or has an increased decibel level, that bearing can be documented and complementary vibration or ultrasound data can be collected to determine what the issue/defect is.

Finally, the best scenario is to use an ultrasound instrument with data storage and data management software to create routes. Data such as decibel levels and sound files can be recorded periodically. How often the



This overlay shows recorded ultrasound files of four motor outboard points on identical motors. One has an obvious bearing defect.

readings are taken should be based on an asset criticality assessment. Once a baseline has been established, a low-level alarm can be set for when a lack of lubrication condition has been detected for a bearing. A high-level alarm is also set to indicate when a bearing has reached the point of initial failure.

If lubrication is not the solution to the problem, a more detailed test would be required to identify the specific defect, such as an inner or outer race bearing fault. When a point along a route has been determined to be lacking lubrication, an inspector can go to that point and apply lubricant until the decibel level drops back down to the baseline level.

Other Ultrasound Applications

Ultrasound imaging or recording is a new concept that involves using a special instrument to analyze ultrasounds, which are then viewed in spectrum analysis software. Although this is a fairly new technique, the use of ultrasound for both mechanical and electrical inspections is growing. The spectrum analysis of recorded ultrasounds can enhance diagnostic accuracy and reduce the subjectivity of only comparing decibel levels or simply what is heard by the inspector in the headset.

Adding ultrasound to mechanical inspections can also allow for better use of other tools such as vibration analysis. If there are too many assets to monitor with vibration, ultrasound can be included to complement the vibration analysis program. Critical assets can benefit from having both vibration and ultrasound data collected. For noncritical assets, which may not necessitate the time to collect vibration data but still need to be monitored, ultrasound data can quickly and easily be used.

Another reason to complement a vibration program with ultrasound is if the vibration analyst's time is limited. A vibration route can be very time-consuming, but ultrasound can help reduce the time it takes to collect vibration data. Ultrasound can be used first, and once the decibel level has risen to trigger an alarm, vibration can further diagnose the problem and the reason for the increase in noise level.

The beauty of adding ultrasound to an existing predictive maintenance and reliability program is that it can be used for many different applications. Typically, those who are starting out on a reliability journey or are just beginning to utilize the technology will employ ultrasound for compressed air and gas leak detection. Tremendous energy savings can be realized through the use of ultrasound for both steam trap and compressed air/gas inspections. Based on these savings, the maintenance and reliability department can gain buy-in from both management and floor personnel. The savings associated with the energy-conservation efforts can then be reinvested in the program by means of additional tools, training, certification courses or even manpower.

The same method for energy-conservation applications can also be used for electrical and mechanical applications. This is what makes ultrasound a versatile and easy-to-use tool for both the well-established maintenance and reliability programs, and those that are just beginning their journey. ■

Pooja Saran| Machniery Lubrication India

INDIA "Mining Sector" STATS

The GDP contribution of the mining industry varies from 2.2% to 2.5% only but going by the GDP of the total industrial sector it contributes around 10% to 11%. Even mining done on small scale contributes 6% to the entire cost of mineral production. Indian mining industry provides job opportunities to around 700,000 individuals.

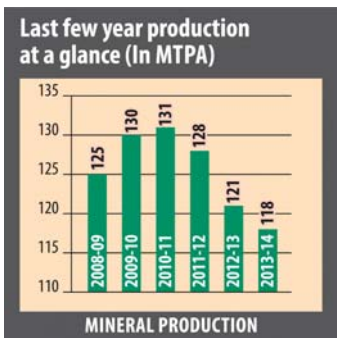
Particulars

80% of mining is in coal 20% - metals & other raw materials (Gold, copper, iron, lead, bauxite, zinc and uranium)

- 89 minerals
- 4 fuel minerals
- 11 metallic
- 52 non-metallic
- 22 Minor minerals

- 1st in production of mica blocks and mica splitting
- 3rd in iron & Steel production
- 3rd in the production of coal & lignite, barites and chromites
- 6th in bauxite and manganese ore
- 10th in aluminums
- 11th in crude steel.

The country is self sufficient in case of 36 minerals and, deficient in respect of a number of minerals. Demand for minerals is expected to grow very fast, due to increasing levels of consumption, infrastructure development, and growth of the economy



Iron and steel is the largest segment of the Indian metals and mining industry, accounting for 73.8 per cent of the overall industry value

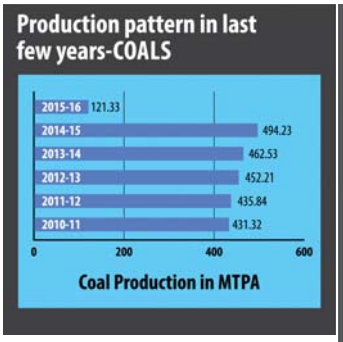
Major Minerals Production in FY2014 & FY2015

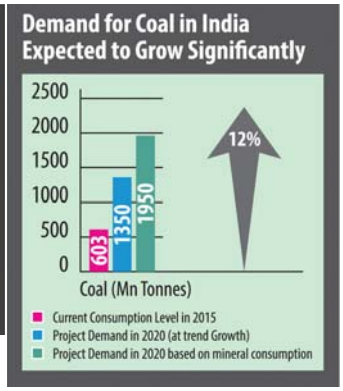
Production level of important minerals in March 2015 were as followings:---

Minerals	Measure(MT)	
	FY14	Fy15
Coal	563.09	541.18
Lignite	44.29	43.37
Natural Gas (Utilized)	34412 mcm	32693 MCM
Petroleum (Crude)	37.78	37.41
Bauxite	21.666	20.201
Chromites	2.852	1.681
Copper Concentrates.	.139	.112
Gold	1564 Kg	1322 Kg
Iron Ore	152.4	129.1
Manganese Ore	2.588	2.166
Zinc	1.490	1.318
Lead Concentrates	0.178	0.194

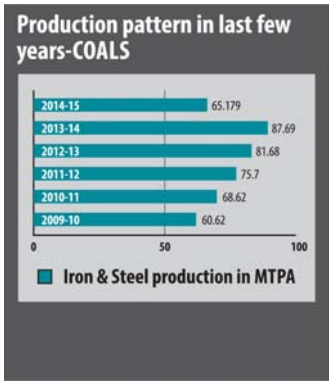
Iron & Coal Production in Pattern

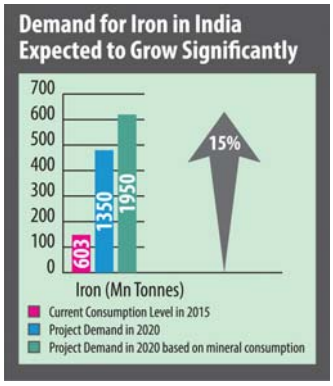
▪ Coal



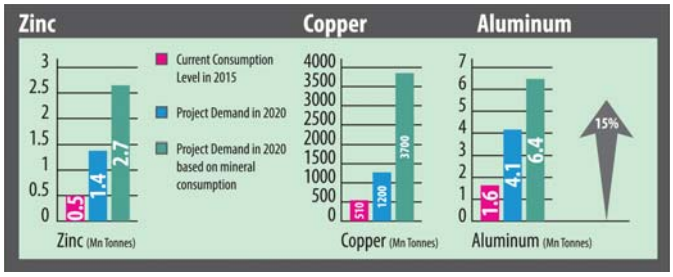


▪ Iron

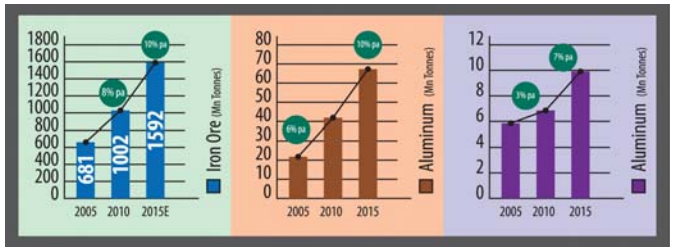




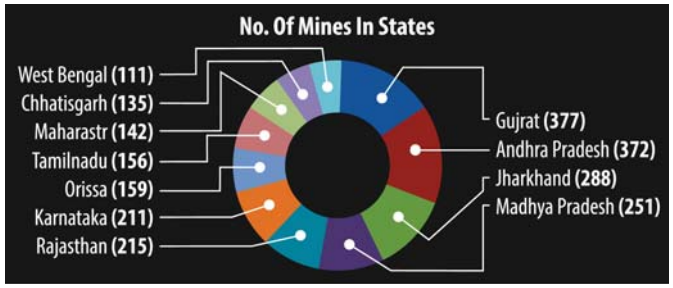
Demand for Other Minerals in India Expected to Grow Significantly

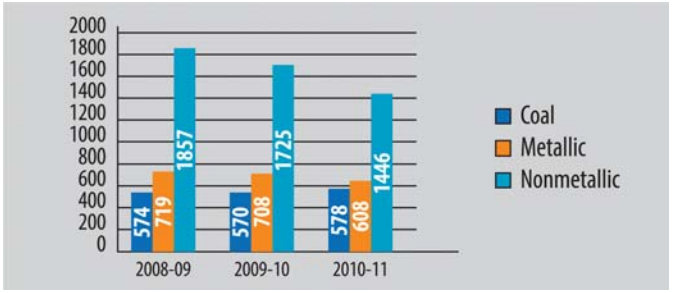


Global Demand of Key Export Minerals of India is Expected to ncrease Significantly



Mining industry & Number of Reporting Mines





Equipment In Industry

Construction and mining equipment cover a variety of machinery such as hydraulic excavators, wheel loaders, backhoe loaders, bull dozers, dump trucks, tippers, graders, pavers, asphalt drum / wet mix plants, breakers, vibratory compactors, cranes, forklifts, dozers, off-highway dumpers (20T to 170T), drills, scrapers, motor graders, rope shovels etc. They perform a variety of functions like preparation of ground, excavation, haulage of material, dumping/laying in specified manner, material handling, road construction etc. These equipments are required for both construction and mining activity.

Construction Equipment	Mining Equipment
Backhoe Loaders	Motor Graders (above 200 HP)
Crawler Dozers upto 320 HP	Dozers (above 320 HP)
Crawler Excavators above 3.5 Cu.M.	Hydraulic Excavators (65 T and above)
Loaders	Rope Shovels
Motor Graders (below 200 HP)	Drag Lines
Skid Steer Loaders	Drills
Wheel Loaders (below 3 Cu.M.)	Wheel Loaders above 3 Cu.M.
Vibratory Compactors	Surface Miners
Dump Trucks (below 35 T)	Off Highway Dumpers (above 35 T)
Tippers topic	Continuous Miners
Road Milling Machines	Long Wall Equipment
Asphalt Pavers	Batching Plants
Asphalt Drum / Wet Mix Plants	
Fork Lifts	
Tower Cranes	
Mobile Cranes – Pick & Carry	
Mobile Cranes 360o slew	
Transit Mixers	

Lubrication In Mining & Equipments

Statistically every single tone of metal produced creates the demand of 1 million lire of lubricant oil. The market for lubricant product in country is estimated at 2.2 billion litres annually.\09p00

Harsh conditions such as dirt, contamination, water, and mechanical loads cumulatively result in a high wear rate of bearings and friction points. Lubrication is therefore absolutely necessary in order to provide the right protection.

- Moisture and particles – combined with heavy loads, shock loads, extreme pressures and continuous operation – create a difficult job for any lubricant.
- Mining gearboxes tend to be overloaded, which leads to overheating and excessive wear. This often results in premature failure of the gears. Other common mechanical issues include emulsification of the gear oil due to water contamination and extreme foaming.

Most wire ropes are lubricated during the wire rope manufacturing process, but the lubricant will not last the life of the rope. When looking for a wire rope lubricant, we should choose a lubricant that contains no acids or alkalis, possesses the adhesive strength to stay on the rope, penetrates between wires and strands, has high fluid film strength, resists oxidation, and remains pliable. It is

important to remember that most wire ropes fail from the inside out. Proper lubrication will help prevent deterioration of wire rope due to rust and corrosion.

Sl. No.	Equipments	Lube Points
1.	Excavator	Diesel Engine
		Hydraulic System
		Pump Transmission
		Swing Device
		Swing Bearing Gear
		Final Drive Gear Box
		Splitter Gear Box
2.	Dozzer	Final drive
		Diesel engine
		Hydraulic System
		Power Transmission
		Pivote Bearing
		Telescope Suspension
3	Drilling Machine	Diesel engine
		Hydraulic System
		Air Compressor
		Feed Gear Box
		Hydraulic Hammer
		Rotation Gear Box
4	Dumper	Diesel engine
		Hydraulic System
		Power Transmission
		Final drive Gear Box
		Final Drive Differential Gear Box

Equipments	Lubricants Used
Large Mobile Equipment Like Dumper	Engine Oils, Hydraulic Oils, Transmissions Fluids, Automotive Gear Oils
Lorries, Dozers, Excavators, Back Hoe	Greases, Brake Fluids, Radiator Coolants, High Pressure Pin Greasing
Rock Drills	Rock Drill Oils, Hydraulic Oils, Semi-fluid Greases
Conveyor Belts (Gear Boxes, Head, Tail And Tension Bearings, Hydraulic System)	Gear Box Oils, Roller Bearing Grease
Compressors	Hydraulic Oils, Compressor Oil (Reciprocating And Screw)-Can Be Synthetic Or Mineral
Pneumatic System	Air Line Lubricant (Pneumatic) Multi-Purpose, EP Type And Graphite Or Molybdenum Disulphide Grease For Anti Seize Of Threading In Drilling Rods.
All Grease Points	Anti Seize Of Threading In Drilling Rods.

SCOTT EVANS, LUBRICATION MANAGEMENT SYSTEMS

The Modern Art of Lubricating Equipment

FIGURE 1. North American's Oldest Dragline

Surface mining is a very old practice in North America. For example, mining for copper at the surface of the Michigan Upper Peninsula appears to have started as early as 5000 B.C. The ore produced through the hard labor of thousands of miners went to the manufacture of hand tools and jewelry. It is estimated by scientists and engineers that given the tools available at the time, it would have taken 10,000 people approximately 1,000 years to excavate the 1.5 billion pounds of ore from this area of Michigan.1

In contrast, it would take approximately 38.5 hours for the fabled Big Muskie dragline to excavate the same amount of material. Perhaps if the Chippewa had the Big Muskie on hand they would not have given up the 30,000 square miles of the Upper Peninsula, with its high-quality copper from Lake Superior.

Talk of surface mining conjures visions of panning in a river during the California gold rush period in 1849. Since that time, North Americans have seen tremendous changes in many areas of life, not the least of which is the surface mining industry. Mining equipment has evolved into some of the most fascinating functional mechanical structures known to man.

As a case in point, take a look at this Bucyrus Class 24, (Figure 1), currently being restored at Reynolds Alberta Museum, located in Wetaskiwin,

FIGURE 2. Bucyrus International, Inc. 2570WS

FIGURE 3. P&H 4100XPB Shovel

Alberta, Canada. This steam-powered dragline, erected in 1917, utilized a 100-foot boom with a four-yard bucket. By comparison, a modern standard size pick-up truck offers about 2.5 cubic yards of space. To move it from one location to another, timbers were placed under the tub and the operator would use the bucket to pull the machine over the timbers to the desired location.

From this primitive beginning, mining tools have evolved into massive machines. Rock drills, front-end loaders, electric cable and hydraulic shovels - some boasting bucket sizes in excess of 50 yards - and mammoth trucks and draglines, such as the Bucyrus International, Inc. 2570WS (Figure 2), have introduced unprecedented levels of productivity for equipment owners and unprecedented challenges for the maintenance staffs. Greatly increased component sizes and load limits have placed tremendous responsibility on the machinery designer and the lubricant system manufacturer, to design and engineer systems that can be counted on to effectively lubricate and sustain these machines.

These machines are often as large as houses, with some booms extending nearly 300 feet. Depending on the type of machine, whether it is a shovel or a dragline or a drill, the machine's key components may be either electrohydraulic or electromechanical. For instance, the P&H 4100XPB shovel (Figure 3) is driven solely by electric motors (no diesel engines) to turn the cab and operate the lift, while the Komatsu Demag Model H655S (Figure 4) employs state-of-the-art electrohydraulic systems. Some draglines have huge hydraulic systems and electrically driven gears, with sump capacities into the thousands of gallons. The rolling stock, including bulldozers and large haul trucks, are powered by diesel engines. Many of the loading and hauling equipment designs incorporate hydraulic systems powered by diesel generators.

As one might expect, effective lubrication of these heavily loaded components is absolutely critical to efficient, reliable, economical operation of a mine site. As the machines have grown in size and sophistication, the manufacturers of lubricant products and delivery systems have had to work equally hard to match the new requirements.

There are two equally important aspects of lubrication effectiveness in the strip mine: the delivery system and the lubricant.

Lubrication Systems

Lubrication distribution systems have improved greatly over the years. Figure 5 is a reasonable facsimile of what would have been used on the Bucyrus 24 dragline in the early 1900s. The lower funnel-shaped half of the unit would be threaded into a port in the bearing housing. The upper cylinder-shaped half would be full of multipurpose

FIGURE 4. Komatsu Demag Model H655S

grease (MPG).

Turning the upper cylinder clockwise would lower the cylinder onto the funnel-shaped portion, forcing (extruding) the lubricant stored in the reservoir of the cylinder portion through the funnel into the bearing. The lube tech would make routine lubrication checks throughout the machine. As required, these lubricators would be turned to ensure the lubricated components received adequate replenishment while in use.

The Lube Systems of Today

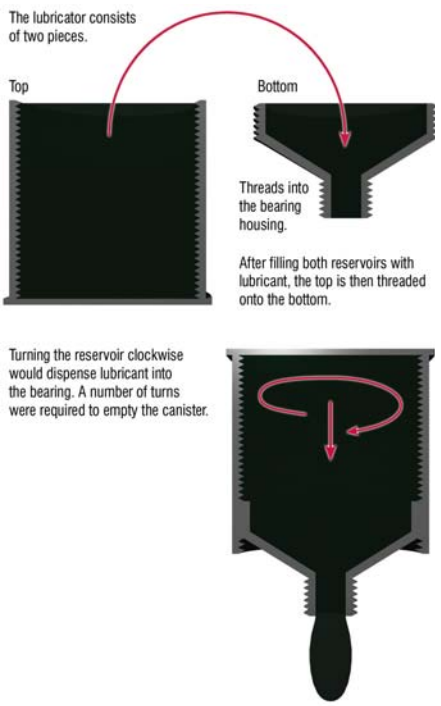
Today's centralized lubrication systems factory-installed on mining machinery have greatly minimized the need for lube techs in most cases. These computerized systems are now capable of dispensing the right product, in the right amount, to the right point, and at the right time.

There are a number of centralized lubrication system manufacturers that offer a wide range of system types and designs to meet the needs of practically any mining application.

Most lubrication systems consist of a grease pump, a motor to drive that pump and some sort of injector or valve to control or measure lubricant volume. Most utilize a programmable logic controller (PLC) to program the frequency of the lubrication replenishment cycle. As sophisticated as some of these systems are, maintenance and proper set-up is essential to ensure that their benefits are realized.

Upgrading

With the advancements in centralized lubrication systems, serious consideration should be taken when selecting a system or upgrading an existing system. Although the system's operation is generally quite simple and effective, performance limitations can have detrimental effects to lubricated



components, such as the impact of changing lubricant viscosity. If a lubrication system is modified to accommodate more lube points or there is a need to change a lubricant product, it is strongly recommended that both the system manufacturer and lubricant manufacturer be consulted before such changes are made.

Lubricants

Lubricant manufacturers have continued to improve their products to meet the needs of bigger, faster machines. Although most lubricant suppliers are not lubrication system specialists, many have the resources to provide technical support, offering sound advice for selecting the products best-suited for the applications.

The products commonly used in mining equipment can be divided into three groups: heavy-duty lubricating oils, such as EP oils for enclosed gear drives; multipurpose engine, circulating and hydraulic oils for engine, bearing lubrication and fluid power; and general purpose grease, for normal industrial bearing applications and specialized mining products.

Walking draglines may require lubricants for the very large plain bearings that support the entire frame of the unit as it moves through the walking process. These lubricants may have a high concentration of lubricating solids or soft metals dispersed into a stiff grease and delivered in small bags (for the walking mechanism without an automatic delivery system) just ahead of the peak loading area. This grease is referred to as a Walking Cam lubricant.

An effort to reduce the number of lubricants on a machine has driven the development of multipurpose products designed to meet several different applications from a single lubrication system. The various components to be

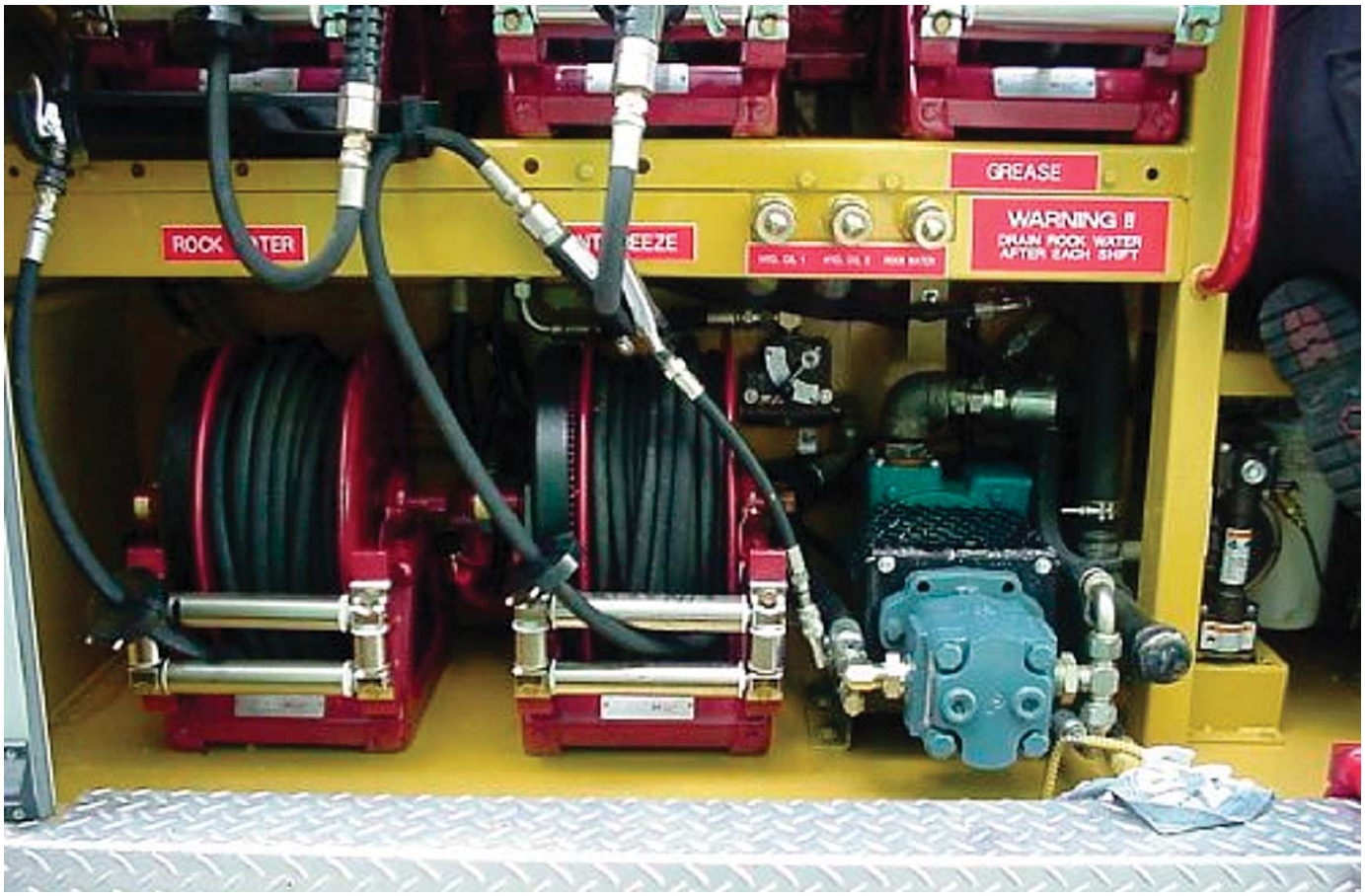


FIGURE 6. Delivery Truck with Lubrication System

lubricated may include the open gears, guide rails, main table bearings and various smaller slides and bearings. This presents a variety of challenges to tackle with one or two products. Specialty product manufacturers strive to meet the wide range of challenges with a single product.

Despite the large volumes involved in filling a dragline during a lubricant change, given the product sophistication, some of these products may cost as much as $2.50 per pound. Management of the lubricant consumption to control costs becomes an integral part of the sourcing process.

Lubricant Management - Supply and Delivery

Vendors offer various options for purchase and delivery of these products, ranging from simply purchasing and managing the distribution of lubricants throughout the mine site, to programs offering on-board delivery, lubrication system set-up and long-term maintenance.

Vendors may use several methods of delivery and replenishing lubrication systems and reservoirs. Today's service equipment, like the delivery truck in Figure 6, is designed to meet the exacting mine delivery requirements. This may include a system of nozzles and hoses piped through filters for each type of lubricant as well as the necessary drive train to assure that the loaded vehicle can get out to the equipment under the worst of driving conditions.

As with any industrial lubrication application, cleanliness must be first and foremost. Contaminated lubricants will dramatically reduce the life of the lubrication system components as well as the lubricated components. The dispensing equipment installed on the truck offers a completely self-contained, clean storage delivery environment, which helps to reduce the risk of contamination for all of the products that are delivered to the equipment.

Full-Service Supply Programs

Product-service combinations have been around the industry for years. Initially offered by specialty lubricant manufacturers, product-service combinations have proved valuable. Most lubricant manufacturers now offer some kind of service supporting their products. The ownership of full-service lubrication programs is completely taken over by the vendor, sometimes with the complete offering being purchased on a cost-per-hour program. Because many lubricant vendors resist consigning products to a mine, the cost-per-hour contract offers the next best option. The purchase of the product is based on the hours of machinery operation. Sometimes these supply programs are provided to mines

in conjunction with other full-service offerings. While this may sound ideal, vendors typically profit from selling less lubricant. Therefore, caution should be exercised when choosing this type of program-vendor combination.

For the simple cost of this combination, the mines should receive a prenegotiated amount of monthly service along with the product. The service cost would be bundled into the cost of product. These programs are advantageous to all when negotiated properly. As long as the level of service doesn't decline over the term of the contract, the benefits of the product-service combination can be considerable.

Lubrication Services Specialists

More recently, independent lubrication service consultants are becoming a viable alternative to the industry. Utilizing an independent consultant offers a mine the ability to purchase the product of choice based strictly on quality and product cost, but without any possible hidden costs of product-service combinations or cost-per-hour contracts. The operators purchase the lube products for the equipment based on equipment criteria and purchase the service of a consultant based on experience and costs. This platform is a unique and upfront approach to product-service combinations. When considering an independent lubrication service consultant, check the individual's references supporting his/her abilities and knowledge.

As the industry continues to evolve, expect to see continued evolution in all aspects of the industry and allied fields. With global positioning satellites (GPS) offering the potential for remotely operated equipment, computer systems taking lubrication systems to new levels of control, manufacturers continuing to meet the demands of an ever-changing and competitive industry, one thing should always remain the same. When it comes to the development and application of lubricating products, providing the cleanest possible environment, storing the products properly, reducing rehandling and applying the right product - in the right amount, in the right place, at the right time - will always be the necessary criteria, no matter how many times these practices are reinvented.

Editor's Note

For an interesting pictorial trip through the task of moving a big stripping shovel, go to www.stripmine.org/spdeup01.htm. A high-speed connection is recommended for the number of pictures in the story.

Photos courtesy of Bucyrus International, Inc., P&H Mining, Komatsu Demag and Lubrication Management Systems, Inc.

Reference

1 www.exploringthenorth.com/cophistory/cophist.html

LOREN GREEN | NORIA CORPORATION

ADVANTAGES of Contracting Out Your LUBRICATION Program

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

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

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

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

Lubrication: A Skilled Trade

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

With the average age of skilled workers approaching 60, more and more of these individuals will be retiring in the next several years. Sadly, few younger workers are entering into the skilled trades, which will leave a huge deficit of trained workers.

If you do not have immediate access to skilled, trained and certified lubrication technicians, it may be time to look into contracting out this function. A good contractor not only can provide trained and certified lube techs but can also help you develop procedures for your lubrication-related tasks as well as implement, maintain and manage your lubrication program. Granted, you will spend more than 5 percent of your

of MachineryLubrication.com visitors say their plant outsources lubrication or maintenance tasks to contract-based laborers

maintenance budget, but in return you will lower your equipment's breakdown frequency and the costs associated with repair parts, overtime, downtime, etc.

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

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

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

About the Author

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

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

BENNETT FITCH | NORIA CORPORATION

FOLLOW the TREND for Successful OIL ANALYSIS

Setting cautionary and critical limits (or targets) for oil analysis results is essential and irreplaceable as groundwork in an oil analysis program. It's what helps answer one of the most commonly asked questions: "Is the oil still good?" Nevertheless, the data changes observed, even if they are within the established limits, can still prove to be valuable. In these conditions, trending oil analysis data is where the value is gained and will help answer what might be the next question asked: "When will my oil go bad?"

If you think about it, 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. Indeed, quality trending provides a powerful means of recognizing when an oil property is moving in an unhealthy or threatening direction.

The most effective way to follow a trend is to consistently collect representative oil samples and track the data from the results by plotting them on a property-versus-time graph. The "property" can be anything from the remaining additives within the oil to the base oil's changing properties or the number and types of particles.

74%

of lubrication professionals say their plant trends oil analysis data, based on a recent poll at MachineryLubrication.com

It is imperative that oil samples are carefully collected and that all variables are minimized or at least addressed. Among the factors that can influence the results include sample location consistency, service life of the machine and oil, makeup oil rates, changes in environmental or operating conditions, oil formulation changes, testing procedure consistency, etc.

The key to success with trending is to learn from the past. This includes others' past failures, not just those of your machines. Start by identifying when certain oil properties have typically been healthy and use this as the standard. Also, take note of when a change in an oil property has previously led to a machine issue or failure. You must develop the awareness to recognize when a change in a particular property could eventually lead to a problem with the machine.

Looking Back at the Past

The world's population growth offers a good example of the types of trends that can exist within machinery. The earth's population has been growing for thousands of years, but it wasn't until around 1800 that it reached 1 billion people. While this was a major milestone, it only took approximately 120 more years to double to 2 billion. Less than 100 years later, the population is rapidly approaching 8 billion people. Many factors have influenced this recent trend, such as the Industrial Revolution and advanced medicine. Figure 1 shows how this rise in population would appear on a graph.

This trend can be compared to the

	HUMAN POPULATION GROWTH	PARTICLE CONTAMINATION GROWTH
Site of Growth	Earth	Lubricated machine
Variables Enhancing Growth	Modern medicine, Industrial Revolution, technology, migration	Lack of wear protection, misalignment, improper ventilation and filtration control
Variables Suppressing Growth	Disease/plagues, war, natural disasters	Proper lubrication, quality machine design, proper ventilation and filtration control
Result of Extreme Population	To be determined	Machine failure

growth of particle contamination in machinery. Particles produce particles. In fact, one particle can generate as many as 20 new particles within a machine. Of course, this will depend on many variables, such as particle ingression rates, the filtration rate, the likelihood of wear generation, etc. Regardless, when particles are the instigator of new particles being created, the contamination can quickly escalate.

By adding quarterly sampling dates and ISO particle contamination codes to Figure 1, we can illustrate a lubricated machine that was accidentally introduced to new contaminants and resulted in increased wear generation. Note the dramatic trend toward the most recent dates in Figure 2. When this type of growth in particle concentration occurs, it will be linked to an imminent machine failure.

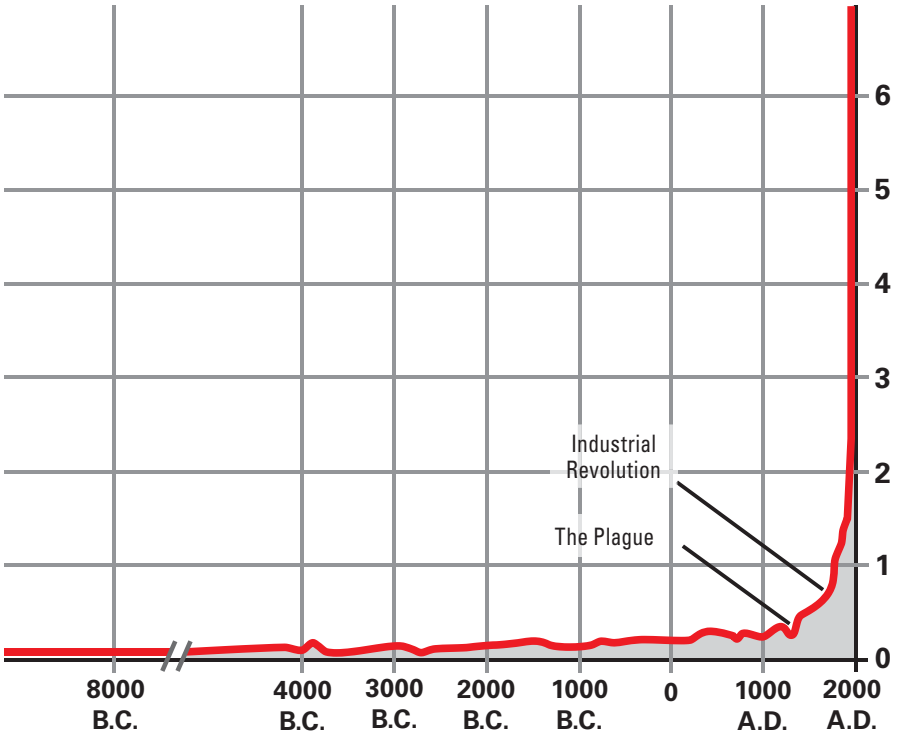


FIGURE 1. The world's population growth

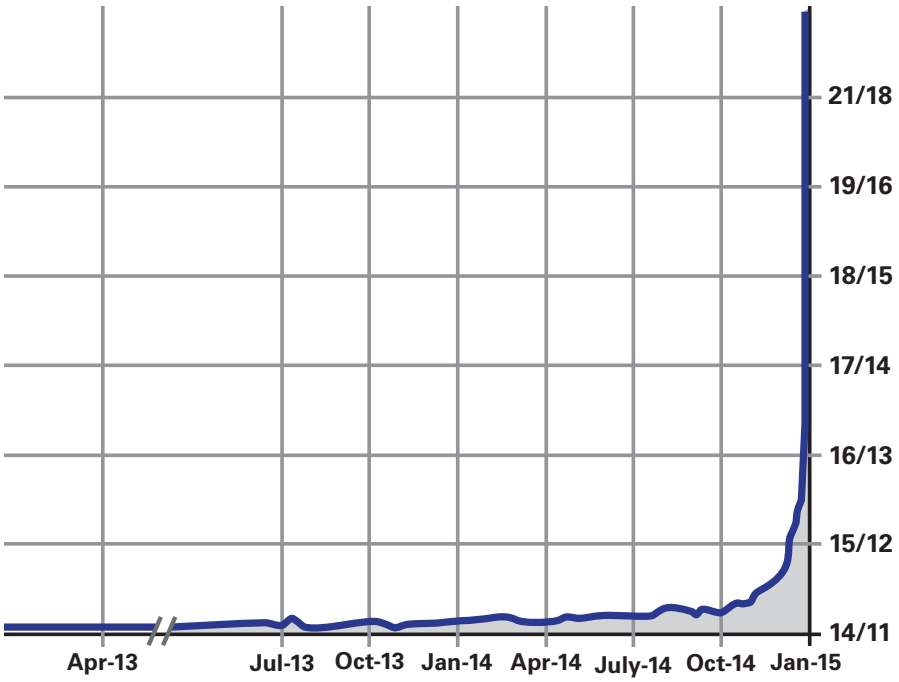


FIGURE 2. An illustration of particle contamination within a machine

Quality trending provides a **powerful means of recognizing** when an **oil property** is moving in an unhealthy or threatening direction.

In order to predict an impending rapid growth of particle contamination, oil sampling must be performed frequently enough to detect a slight uncharacteristic increase. For example, in Figure 1, if the world population is measured every 1,000 years, the results would be 0.1 billion, 0.1 billion, 0.1 billion, 0.2 billion, 0.2 billion and finally 7 billion. However, if the population is measured twice as frequently or more, it would be much easier to recognize the start of the abnormal increase. Sampling machines for changing oil conditions is no different. ■

About the Author

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Alejandro Meza | Noria Corporation

Machine MODIFICATIONS That INCREASE Reliability

The ultimate goal of lubrication excellence is to increase machine reliability and reduce operating costs. To achieve this objective, changes must be made at different levels of the plant, including the technology and hardware that are currently in use.

Machines may require modifications for a variety of reasons, such as to improve the accuracy of lubrication procedures, to enable inspections of the in-service oil and the machinery, to ensure precise oil analysis and consistent oil sampling, and to enhance the effectiveness of the contamination control program. Following is an overview of these types of modifications.

Lubrication Procedures

It is critical that machines receive the right lubricant in the right amount at the right frequency. It is also essential that they are lubricated using clean, ergonomic and safe procedures. To ensure proper lubrication practices, machines must have the appropriate accessories installed. This typically involves lubricant-delivery devices like constant-level oilers, single-point lubricators, grease fittings, grease purge valves, centralized lube systems, spray systems, etc. Temperature-management systems, including heaters and coolers, may also be needed, along with rolling-element bearing seals and shields, and power-flush quick-connects on reservoirs and sumps.

Inspections

Oil analysis that is supported by visual inspections of the in-service oil offers a powerful way to monitor the condition of the oil and the machine. Simple visual inspections can confirm that the oil is in good condition or indicate the presence of contaminants or excessive degradation. Among the devices that may be installed to facilitate inspections of the oil include bottom sediment and water (BS&W) bowls, which enable quick inspection of low-lying contaminants and sludge, and level gauges, which should be located near fill ports and be large enough to easily determine the oil level.

From time to time, machines should be inspected internally to verify that the lubrication system and machine components are free of deposits and excessive wear. External inspections are also useful to identify the presence of leaks or abnormal operating conditions. A number of machine modifications or accessories can be employed for this purpose. For instance, large reservoirs and sumps should be equipped with inspection hatches. These hatches, which can be opened for a visual inspection and then sealed again, should incorporate lips, gaskets and compression clamps/bolts to control accidental dirt entry, ingression and air movement. Magnetic drain plugs and other inspection devices enable wear metals to be

24% of lubrication professionals say improving the accuracy of lubrication procedures would be the most likely reason for making machine modifications at their plant, based on a recent poll at MachineryLubrication.com

examined and removed from the oil. External modifications can allow for visual inspections of lube points, chains, couplings, belts, etc. Minor hatches or plugs may also be removed to introduce a camera or borescope.

Oil Analysis

Oil sampling is key to the success of an oil analysis program. Oil samples obtained incorrectly will produce faulty technical reports and an inaccurate machine diagnosis. An example of a machine modification for proper oil sampling would be installing a primary sampling port. These ports should be positioned according to the lubrication system's configuration. Secondary sampling ports can also be useful for monitoring specific components.

Installation of in-line instrumentation will be necessary for real-time lubricant monitoring in large or critical machines. These types of sensors include fluid pressure gauges, flow meters, temperature gauges, free water alarms, low oil level alarms, pressure differential gauges, filter bypass alarms, air-intake vacuum gauges, etc.

Contamination Control

A well-structured contamination control program is a strategic element of proactive maintenance. It addresses and helps to eliminate the root causes of critical machine failure modes. A wide range of machine modifications can be made to enhance contamination exclusion and removal, such as incorporating circulating systems with quality oil filters, high-performance breathers, hydraulic cylinders equipped with rod boots to control ingression, reservoirs designed with baffling to enable contaminants to settle or detrain, and return-line diffusers to control tank aeration. Other alternatives would be to install dust protection covers where grease fittings are used and offline filters on bath-/splash-lubricated machines. You may also need to use headspace management equipment with large reservoirs.

Retrofitting machines is a smart strategy for reducing operating costs. It will require full support from management and an allocation of resources, but the return should be several times the investment. Of course, before any equipment modifications are made, it is necessary to assess each machine based on its criticality and operating conditions. Safety and ergonomics must also be considered. While this may take some time, it will pay off in the long run with increased machine reliability. ■

Retrofitting machines will require full support from management and an allocation of resources, but the return should be several times the investment.

A high-efficiency breather for particles and moisture

A single-point lubricator

About the Author

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

By Suzy Hitchcock, ICML

ICML Marks 14 YEARS of INDUSTRY SUCCESS

In 2001, when the International Council for Machinery Lubrication (ICML) offered its first certification exam, few could have envisioned the organization becoming the world leader in the certification of lubrication technicians and oil analysts. However, following 14 years of consistent and impressive growth, ICML has now administered more than 21,000 exams to practitioners from more than 100 different countries. Exams are currently offered in English, Spanish, Portuguese, Korean, Japanese, Chinese, French, Italian, German and Russian. The organization is also looking to translate its exams into additional languages to ensure qualified individuals are able to test their skills equally.

Thanks to ICML's rapid global expansion and successful track record, its certification programs in effect have become world standards on the certification of technicians, with thousands of companies worldwide using its credentials for skill-based hiring and promoting. The International Organization for Standardization (ISO) has even incorporated ICML's certification programs as the basis for its two international standards on the certification of oil analysis personnel. ICML's Machine Lubrication Technician (MLT) and Machine Lubricant Analyst (MLA) programs were pioneered into ISO 18436-4 for field-based personnel, while ICML's Laboratory Lubricant Analyst (LLA) program was expanded and forged into ISO 18436-5 for laboratory-based personnel.

Over the years, ICML has continued to support lubrication standards development, with its volunteers being active in various committees and working groups responsible for standards relating to the application of lubrication and oil analysis best practices. ICML serves as a voice for industry to advocate for necessary standards and welcomes suggestions for specific issues needing standardization.

Besides certification and standards development, ICML helps to dignify the careers of lubrication practitioners by recognizing excellence in industry and identifying future industry mentors through its awards programs. The Augustus H. Gill and John R. Battle awards, which are presented for excellence in oil analysis and lubrication, recognize end-user programs around the world and bring global prestige and respect to lubrication champions and their teams. The focus of the awards is not just to identify award recipients but to encourage excellence and create a means to share best practices among user organizations on a global scale. The awards are open to companies worldwide at no cost to the applicants and are independent of any involvement by the applicant companies in any area of ICML activity. The awards criteria serve as a roadmap for organizations in their journey to world-class lubrication and oil analysis initiatives.

Most importantly, ICML has become a global community of lubrication and oil analysis practitioners who are deserving of recognition and support. The organization's volunteers have a passion to do right by its members and have an incredible commitment to make ICML work.

It has been said that industry rides on a precious and delicate film of oil. Just how much this film of oil influences economic health, job stability and the environment is becoming more and more evident. Industry is increasingly open to a more proactive approach to maintenance in order to improve asset reliability and productivity. It is also awakening to the fact that none of these initiatives really matters if the individual performing lubrication tasks is not properly trained and supported. ICML's mission is to help more people understand and appreciate this crucial role.

For more information on ICML's certification programs and how to join the organization, visit www.lubecouncil.org.

DHIREN SHAH

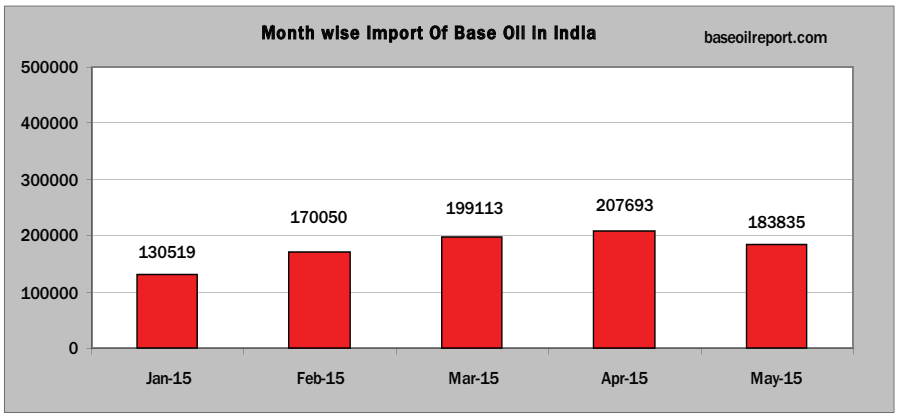
BASE OIL REPORT

Contrary to the popular view, global crude oil prices moved up after a small dip in the aftermath of Iran reaching a deal with the US and other large countries on its nuclear programme. It would be months before any incremental Iranian crude oil reaches the market, with the timeline depending on several other factors. Under the circumstances, oil prices may not come down dramatically, but are likely to remain range-bound for 6-12 months, before any meaningful supply from Iran can tilt the balan. At its peak in 2007, Iran was producing nearly 4 million barrels a day (mbpd), of which 2.3 mbpd was exported. While its production suffered since mid-2012 post the US and EU-led sanctions, it averaged 2.8 mbpd in 2015 with exports of about 1 mbpd. There was a widely shared perception that there may be a glut soon after a deal. But no fresh supply from Iran would flow into the market before 2016, say experts. "By October 15, Iran must show that it has met its commitments and the International A .. By October 15, Iran must show that it has met its commitments and the International Atomic Energy Agency hopes to issue a final report by December 15.On the other hand, the US Congress has 60 days to debate over the deal before reaching a conclusion. The US President Obama has already clarified that he would veto any legislation preventing the deal. Even if everything moves as planned, it is not known how much incremental crude Iran could add to the global pool.During the period January 2015 to May 2015, India imported 891210 MT of Base Oil. The country imported 130519 MT in January, 170050 MT in February, 199113 MT in March, 207693 MT in April and 183835 MT in May 2015. Compared to the previous month i.e. April 2015. Base Oil import of the country has decreased by 11% in May 2015. Compared to the same month last year i.e. May 2014, Base Oil import had gone down by 13% in May 2015.

The Indian base oil market remains steady with inventories at optimum levels with surplus of imported grades. During the month of May 2015, approximately 183835 MT have been procured at Indian Ports of all the grades, which is 11% down as compared to April 2015, Major imports are from Korea, Singapore, USA, UAE, Iran, Taiwan, France, UK, Netherlands, Japan, Italy, Belgium, etc. Indian State Oil PSU's IOC/HPCL basic prices for SN – 70/N – 70/SN – 150/N -150 marked up by Rs. 0.70 per liter, while SN - 500/N - 500 is jumped by Rs.1.20 per liter. Bright Stock price is up by Rs. 1.60 per liter. The prices are effective July 01, 2015. Hefty Discounts are offered by refiners which are in the range of Rs. 15.00 – 17.00 per liter for buyers who commit to lift above 1500

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

Month	Group I - SN 150 Iran Origin Base Oil CFR India Prices	N-70 Korean Origin Base Oil CFR India Prices	J- 500 Singapore Origin Base Oil CFR India Prices	Bright Stock Europe Origin CFR India Prices
April 2015	USD 610 – 615 PMT	USD 660 - 665 PMT	USD 700 - 705 PMT	USD 910 - 920 PMT
May 2015	USD 640 - 645 PMT	USD 690 - 695 PMT	USD 730 - 735 PMT	USD 940 - 950 PMT
June 2015	USD 640 – 645 PMT	USD 680 - 685 PMT	USD 735 - 745 PMT	USD 960 - 970 PMT
	Since April 2015, prices have gone up by USD 30 PMT (5%) in June 2015.	Since April 2015, prices have increased by USD 20 PMT (3%) in June 2015.	Since April 2015, prices have firmed up by USD 35 PMT (5%) in June 2015.	Since April 2015, prices have surged up by USD 50 PMT (5%) in June 2015.



MT. Group I Base Oil prices for neutrals SN -150/500 (Russian and Iranian origin) are offered in the domestic market at Rs. 45.10 – 45.20/45.90 – 46.05 per liter, excise duty and VAT as applicable Ex Silvassa in bulk for one tanker load. At current level availability is not a concern.

The Indian domestic market Korean origin Group II plus N-60–70/150/500 prices at the current level have been marginally up. As per conversation with domestic importers and traders prices reflects minimal changes for N – 60/ N-150/ N - 500 grades and at the current level are quoted in the range of Rs. 45.50 – 45.95/45.85 – 46.30/47.60 – 48.20 per liter in bulk respectively with an additional 14 percent excise duty and VAT as applicable, no Sales tax/Vat if products are offered Ex-Silvassa a tax free zone. The above mentioned prices are offered by a manufacturer who also offers the grades in the domestic market, while another importer trader is offering the grades cheaper by Rs.0.35 – 0.45 per liter on basic prices. Light Liquid Paraffin (IP) is priced at Rs. 45.50 – 46.00 per liter in bulk and Heavy Liquid paraffin (IP) is Rs.49.50 – 50.60 per liter in bulk respectively plus taxes extra.

During the month of February 2015, India imported 170050 MT of Base Oil. The country imported 91948 MT (54%) from Korea, 33396 MT (20%) from Singapore, 18487 MT (11%) from Spain, 12707 MT (7%) from UAE, 10185 MT (6%) from other countries and 3327 MT (2%) from Bahrain.

While in the month of February 2015, India imported 170050 MT of Base Oil, India imported the huge quantum in small shipments on different ports like 120721 MT (71%) into Mumbai, 32747 MT (19%) into JNPT, 7367 MT (4%) into Chennai, 4486 MT (3%) into Ennore, 3388 MT (2%) into Kolkata and 1341 MT (1%) into Other Ports.

Approximately 7325 MT of Light & Heavy White Oil has been exported in the month of February 2015 from JNPT. Compared to last month i.e. January 2015; exports of the country have gone up by 30% in the month of February 2015. It has been exported to Egypt, Iran, Puerto Rico and USA.

Approximately 5583 MT of Transformer Oil has been exported in the month of February 2015 from JNPT, Village Ponneri, Raxaul LCS and Chennai. It has been exported to Bangladesh, Brazil, Indonesia, Iran, Korea, Kenya, Morocco, Myanmar, Nepal, Newzealand, Nigeria, Oman, Paraguay,Indonesia, South Arabia, South Africa, Singapore, Thailand, UAE and Vietnam.

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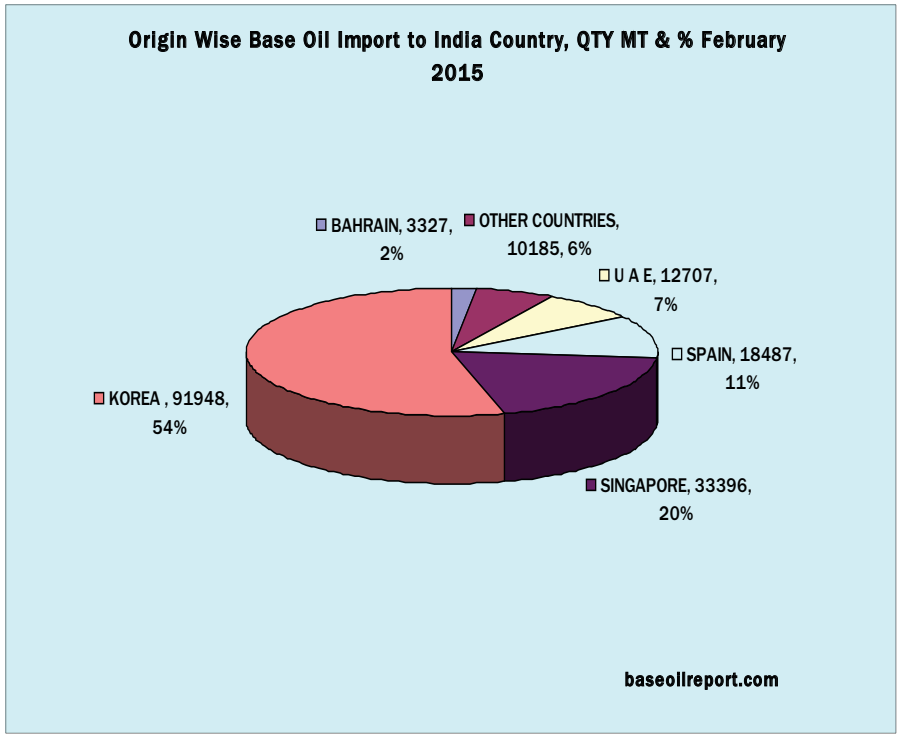

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