Lube-Tech
PUBLISHED BY LUBE: THE EUROPEAN LUBRICANTS INDUSTRY MAGAZINE
No.111 page 1

Unlocking Efficient, Reliable Power

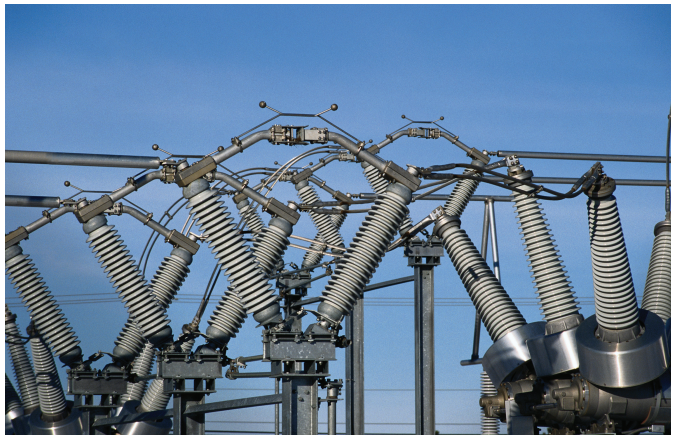
In power, every day is critical. When people flick a switch, they expect the power to be there instantly. Globally the demand for power is increasingly driven by a growing population, mass urbanisation, and rapid industrialisation of nations like China and India. The consequence for those in power generation, transmission and distribution is a need to achieve greater productivity and reliability, in a climate of stricter environmental targets, severe supply interruption penalties, tighter budgets and tougher operating conditions. For power generator systems, many of which supply emergency power for key infrastructure, such as hospitals and pumping stations, this is particularly critical.

Most companies are aware that reducing Total Cost of Ownership (TCO)[1] over the lifetime of machinery is key to extracting the best value. However, an international survey of power companies commissioned by Shell Lubricants[2] reveals businesses underestimate the potential productivity gains and cost savings from effective equipment lubrication.

Only 32 percent of the companies surveyed believe effective lubrication can help improve equipment availability, while 49 percent stated they wouldn't expect higher-quality lubricants to help reduce maintenance costs.

In general, the cost of lubricants accounts for less than 5% of a power generation company's total operational expenditure[3]. Yet Shell Lubricants believes lubrication can deliver significant business value through improved system efficiency, reliable equipment protection, and longer oil and equipment life. When evaluating the effect of lubricants on TCO, Shell Lubricants considers the end to end impact on maintenance budgets and processes, and also any costs related to lost production during equipment downtime.

In reality, power companies are incurring significant costs from errors in equipment lubrication. Companies surveyed admitted that around six in ten incidences of unplanned downtime in the last three years were likely due to their incorrect selection or management of lubricants. In addition to impacting reliability, this is having a financial impact, with 26% of companies estimating that these shutdowns cost their business at least $250,000 (£197,000) and one in five (18%) state that costs have exceeded $1 million (£790,000).

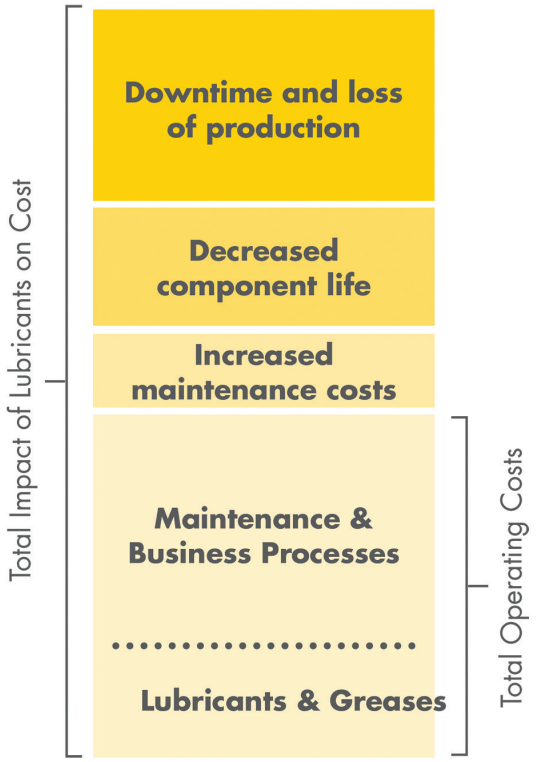


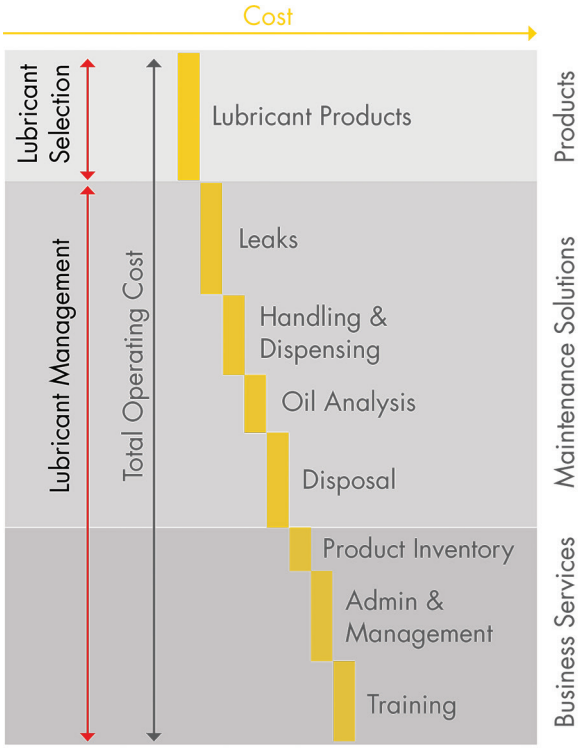
In fact, optimising lubrication can help extend component life, reduce maintenance costs and limit unplanned downtime, contributing to savings far higher than the price of the lubricant itself. Understanding how lubricants contribute to TCO is the first step to realising potential savings.

There are two key elements to seizing this opportunity; the first is selecting the right lubricant; the second is effective lubrication management.

[1] *Total Cost of Ownership (TCO) is defined by Shell Lubricants as the total amount spent on industrial equipment, including cost of acquisition and operation over its entire working life, including costs of lost production during equipment downtime.*
[2] *Survey commissioned by Shell Lubricants and conducted by Edelman Intelligence, based on 212 interviews with Power sector staff who purchase, influence the purchase or use lubricants / greases as part of their job across 8 countries (Brazil, Canada, China, Germany, India, Russia, UK, US) from November to December 2015.*
[3] *Source: http://s05.static-shell.com/content/dam/shell-new/local/country/aus/downloads/pdf/lubricants/power-engine-family-brochure.pdf.*

COMPONENTS OF TOTAL COST OF OWNERSHIP (TCO)





PARTNERING FOR INNOVATION EXCELLENCE

Whether it's a turbine, transformer or stationary engine, every piece of power generation machinery or transmission/distribution transformer made by different Original Equipment Manufacturers (OEMs) has its own specific oil requirements.

OEMs define the minimum requirements for lubricants but for critical equipment, lubricants that exceed rather than simply meet these standards can prove a worthwhile investment. Technical Partnerships with customers, including OEMs and utilities companies, help steer the development of oils and greases for the latest equipment technology. Field trials with customers also validate performance in real-life scenarios and demonstrate how products can help improve equipment performance, efficiency and reliability.

The process of creating a new lubricant – from selecting components, to rigorously testing the formulation and conducting field trials – is highly complex and can take several years. In some cases, lubricants evolve over decades, with developments in chemistry and technology innovations. A lubricant's precise blend of base oil and additive package helps ensure that it is able to deliver optimum performance for the longest possible time in a cost-effective manner.

THE FOUR KEY FUNCTIONS OF LUBRICANTS

The four key functions each play a different role in helping to cut TCO. Achieving the best balance of functions can help maximise the impact on TCO and equipment efficiency:

1. **Reduce friction** – Lubricants form a fluid barrier between moving surfaces. This reduces friction between them, helping maintain smooth running and limit wear.
2. **Clean and Sealing** – Lubricants flush away contaminants, removing dirt and wear particles from vital areas for removal via filtration. Many lubricants also contain active detergents for more powerful cleaning. Greases have a sealing effect, to help keep out contamination.
3. **Protect** – Lubricants prevent corrosion caused by acids, water and other agents by coating surfaces with a protective barrier and through inhibitors that neutralise harmful chemicals. Greases also form a physical barrier to protect against contamination.
4. **Cool** – Lubricants absorb excess heat from high temperature zones and transfer it away for cooling. This allows the equipment to function efficiently.

LUBRICATION CHALLENGES

For any piece of equipment, the design characteristics, how it is fuelled and its operational parameters all pose different challenges for lubrication.

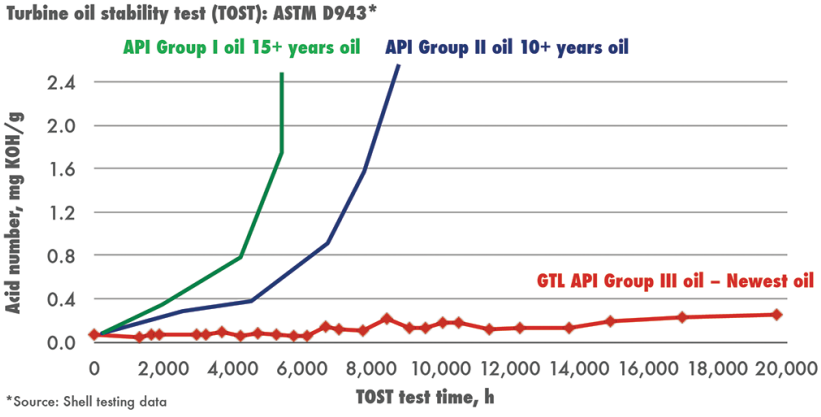
TURBINES

Today's power generation turbines are working under more demanding conditions than ever – from continuous 24/7 running, to frequent stop-start cyclic operation to accommodate fluctuating power generation.

As a result, modern turbine oils must be able to cope with increased stress and considerable design and operational challenges, including reduced downtime, extended oil drain intervals, higher temperatures and loads. Greater turbine output power, combined with a lubricant reservoir that is the same size or smaller, is also imposing more rapid cycle times on lubricants, resulting in the need for excellent surface properties.

Looking at the ratio of turbine megawatt output to oil volume gives an indication of oil stress, and increases are being seen of up to 400% with the latest turbines. This is having a big impact on the types of lubricants required by power generation customers. Turbine oils need to help deliver value through extended oil and asset life, enhanced equipment protection and excellent system efficiency.

As turbines have developed, oil has improved. TOST (Turbine Oil Stability Test) life provides a comparative measure of how quickly different oils degrade under the same severe conditions. Twenty years ago, turbine oil might have been expected to last to around 5,000 hours, whereas today it lasts >10,000 hours. The figure below compares the oxidative stability of different oils.



WIND TURBINES

Wind power is playing an increasingly prominent role in today's global energy mix. Industry projections suggest that existing installed capacity will double by the end of 2019[4].

The past decade has seen vast increases in size and capacity of both on and off-shore wind turbines. Tower heights now commonly reach 80-120 m, rotor diameters average 95 m or more, and average output capacity has increased to 1.96 MW, or 3.6 MW for offshore. In addition, 27% of wind turbines installed in 2014 use direct drive technology, and this trend is growing.

All of this poses a number of challenges for lubrication. Longer turbine blades result in increasing loads and vibration on bearings, which can cause increased wear. While the high flow rate for gear oils in a wind turbine gearbox (in cases 200 L/min or more) means that the oil has little time in the sump to release any entrained air. As such, gear oils need to be designed with low foaming tendency.

With turbines often located in extreme climates, lubricants must be able to perform efficiently in spite of freezing winters, or at the other extreme, very high ambient temperatures and frequent sand storms. For turbines located off-shore or in coastal environments, protecting bearings against corrosion by sea water is also vital. At the same time, the lubricant must resist the formation of harmful deposits and retain its wear protection properties when contaminated with water. The longer an oil resists degradation, the longer the oil and machinery can keep working.

STATIONARY ENGINES

For natural gas engines, key among the challenges are the increased risk of carbon deposit build-up on the piston ring grooves and piston top land, especially in new generation high output, high Brake mean effective pressure (BMEP) gas engines, along with an increased risk of ash deposit build-up in the combustion chamber that can lead to costly unplanned downtime. Engines operating on sour gases are at risk of greater deposit build up due to siloxanes, along with corrosion as a result of halogenic compounds and acidic elements being present in the gas. The oxidation and nitration of engine oils can also significantly increase the acid stress and shorten the oil's life.

[4] *Source: Global Wind Energy Council, Global Wind Report, Annual Market Update 2014.*

Lubricants need to protect the engine and extend equipment life by both controlling carbon deposit and ash build up, and neutralising acids produced during combustion or by the oxidation and nitration of the oil itself. Therefore, lubricants should have a low-ash content to minimise deposit build up, but a balance between ash level and performance is needed to ensure system efficiency is not compromised. Ash content needs to be sufficiently high to manage alkalinity reserve depletion but not so high that it leads to wear and deposits.

For heavy-duty diesel/heavy fuel engines, fuel quality presents a similar challenge for engine oils. Low quality fuels can have high sulphur and asphaltene content, resulting in the need for engine oils to meet the challenges of cold corrosion and base number (BN) depletion. While heavy fuel oil (HFO) engines also present the challenges of increased oil viscosity, high-temperature corrosion and deposit build-up due to contamination with high asphaltene fuels.

While lubricants are designed to neutralise acid and prevent corrosion during combustion, the oil BN, and consequently the oil life, can be reduced in the process. Sweetening can be conducted in order to prevent the need for a full oil change - this involves draining and replenishing a small amount of oil to boost the BN.

Over time however, this can accumulate a significant amount of waste oil, resulting in costly storage and disposal. The goal, then, is to bring down oil consumption and sweetening, and therefore TCO.

TRANSFORMERS

The average age of a power transformer in many countries is around 30 years or older and many companies are operating equipment close to or beyond its original recommended lifespan due to the high capital cost involved in replacing a unit. Many transformers frequently operate under overload, with larger voltages to improve transmission efficiencies and higher power:weight or power:volume ratios to reduce manufacturing and installation costs. This means transformer oils must work effectively for longer and in higher temperatures. They also need to be able to protect against copper corrosion, paper degradation and premature oil ageing.

UNLOCKING VALUE THROUGH OPTIMISED LUBRICATION

By selecting a high performing oil, power sector companies can realise TCO savings that reach far beyond any savings related to the price of the lubricant itself. Turbine oils made using GTL (gas-to-liquid) technology, hold the key to increasing productivity over an increased time, whilst helping to keep the risk of costly equipment breakdowns to a minimum.

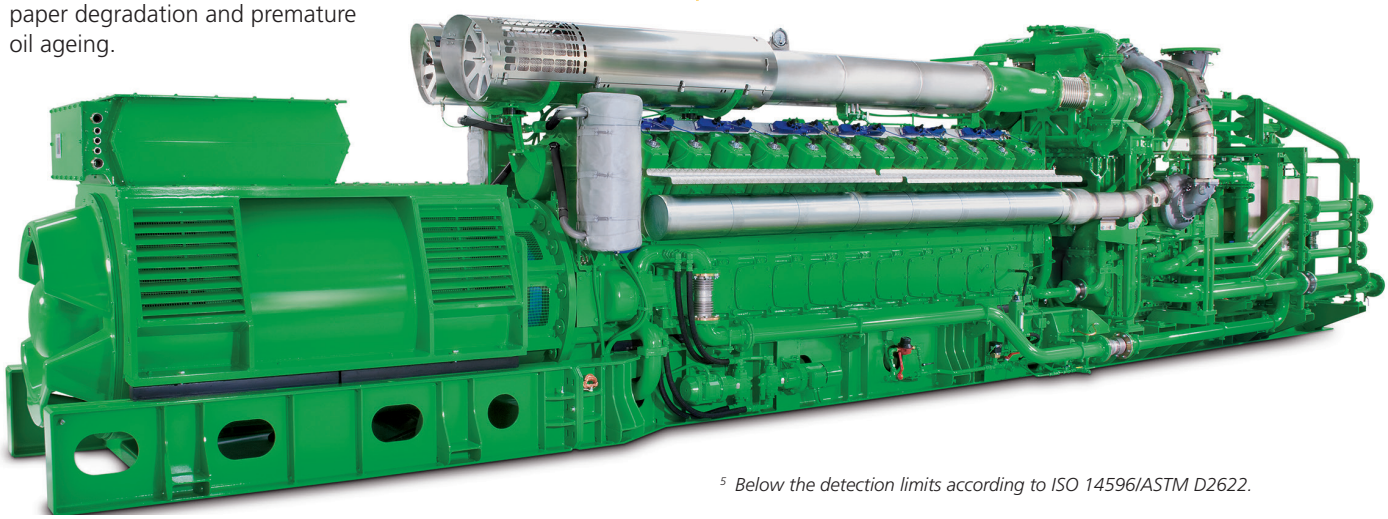
These are produced from natural gas using a proprietary gas-to-liquids (GTL) process. With no sulphur[5] and very low aromatic and unsaturates contents, these GTL base fluids typically have higher flash points, lower densities and more effective thermal properties than conventional mineral oils, and when additivated have significantly longer resistance to degradation.

Selecting a less effective lubricant rarely results in immediate equipment failure, but can lead to increased maintenance expenses over time and, in the event of disruptions from unplanned downtime, heavy financial penalties. These mounting costs can be far greater than the savings from selecting a lower price lubricant.

In contrast, a high-performance, high-quality lubricant that keeps equipment clean of deposits, and effectively protects against wear and corrosion and other lubricant related problems can help extend equipment life, reduce frequency of breakdown and increase equipment availability. This could significantly decrease spend on spare parts and maintenance over the life of the asset.

EFFECTIVE LUBRICATION MANAGEMENT

In addition to selecting the right product, effective lubrication management is vital to unlock potential TCO savings. Even the best product cannot perform effectively if it does not reach the right surfaces in the equipment at the right time, in the right amount, without being contaminated or degraded. Effective lubrication management can help deliver value from improved productivity and reductions in lubricant consumption, maintenance and operating costs.



[5] *Below the detection limits according to ISO 14596/ASTM D2622.*

One of the main lubrication management challenges commonly faced by power companies is contamination control. This is critical to maximising the performance of the lubricant in equipment. How the lubricant is stored, handled and transported through the site greatly impacts the likelihood of contamination. Storing drums in a sheltered place and wiping the top clean before it is opened will help limit the risk of contamination by water and particles. Applying filtration can also help ensure product cleanliness before oil enters equipment.

Also important is regular lubricant monitoring and analysis, to ensure the lubricant is functioning well and remains fit for purpose, essentially giving it a regular health check. This can provide early warning of equipment malfunction or wear or lubricant degradation, enabling the lubricant to be changed before issues escalate and thereby helping reduce the frequency, time and cost of maintenance. This also helps improve productivity due to greater equipment availability.

Oil condition monitoring services, such as Shell LubeAnalyst, are available to support customers by providing early warning of equipment wear or lubricant degradation or other problems. This enables the lubricant to be changed before issues escalate, thereby helping reduce the frequency, time and cost of maintenance. This also helps improve productivity due to greater equipment availability.

Underpinning good lubrication management practices are industry knowledge and expertise. Yet, 59% of power companies surveyed admit they don't conduct staff training on lubricants as regularly as they should, and only 43% have all the recommended procedures in place[6] to manage and monitor lubricants effectively.

A common mistake is limiting the oil drain intervals (ODIs) even though the condition of the oil or equipment remains satisfactory. Implementing an effective lubrication monitoring programme can allow companies to increase ODIs and, ultimately, achieve savings. There can be significant benefits to changing the lubricant based on the results of analysis rather than only at fixed, predetermined intervals, particularly when equipment is operating in demanding conditions.

With a gap in staff expertise and only 25 percent of businesses making use of regular visits from their lubricant supplier's technical staff, most companies are not well equipped to take action. Power companies should follow six steps for the good management of oil and greases:

1. **Right storage and handling** – oils and greases must be stored in the right conditions and handled correctly to avoid contamination and preserve their key characteristics
2. **Right place** – for the oils and greases to reach the right surface they must be properly applied to the equipment
3. **Right time** – the correct frequency of oil change or re-greasing ensures the lubricant reaches the surface at the right time. Delays can result in accelerated wear
4. **Right amount** – the correct volume of oil or grease applied and topped up to protect moving parts effectively
5. **Right monitoring** – regular sampling and analysis to ensure the oil or grease remains fit for purpose and check for early indications of loss of equipment performance. Inspections also ensure the consistent application of the first four steps
6. **Right people** – the competence of those who lubricate equipment can greatly affect its positive impact, particularly when it comes to ensuring all of the above happens

TURBINE OIL UPGRADE AND OIL CONDITION MONITORING SERVICE SAVES STEEL PRODUCER USD $57,088[7]

One such customer is Jiangsu Shagang Group (Shagang), one of the largest steel producers in China. The company was experiencing problems in its power plant steam turbines just a few months after commissioning the new equipment. It discovered that excessive steam ingress to the lubricant system had caused the turbine oil to emulsify and significant amounts of sludge to settle at the bottom of the sump. The excessive contamination had also contributed to accelerated wear of two journal bearings.

Following a review of the turbine lubricant system, oil analysis data and discussions with site management, turbine reliability was improved and a new lubricant was recommended for its robust demulsibility control, which means excess water can be easily drained from the steam turbine lubrication system, helping to minimise corrosion and premature wear, and lower the risk of unplanned maintenance. As a result, the company reported annual savings of USD $57,088.

A STRUCTURED APPROACH TO UPGRADING LUBRICATION

A look at companies who have successfully implemented structured, TCO-driven lubrication projects reveals a number of initial actions that help drive success.

[6] *Shell recommended procedures include: Delivery and storage of oils / greases, Oil change procedures, Oil dispensing systems, Efficient grease lubrication systems, Oil analysis, Training employees in lubricant selection and/or management.*

[7] *The savings indicated are specific to the calculation date and mentioned site. These calculations may vary from site to site and from time to time, depending on, for example, the application, the operating conditions, the current products being used, the condition of the equipment and the maintenance practices. More details available on request.*

Senior management support for a TCO-driven approach to lubrication is critical, to help overcome challenges such as resourcing alongside the demands of daily operations. It is also important to have a dedicated team in place to help implement and drive this change across the company. This will allow a project lead to allocate appropriate time and resources to a team tasked with implementing changes. Leveraging your relationship with your lubricant supplier can give access to their technical teams, who can play a key role in identifying and delivering value.

A comprehensive analysis can allow you to identify, quantify and prioritise TCO-related projects. A key element of this is aligning on how value is measured to enable savings to be recorded accurately. For example, what is the hourly cost of maintenance and time required for repairs; what is the cost of replacement parts; what is the benchmark failure frequency and what is the monetary value of downtime for each piece of equipment, in terms of lost production? Setting measurable targets in the initial stages of the process allows you to ensure that progress can be tracked.

These steps have helped companies form a strong foundation from which to successfully incorporate a TCO-driven approach to lubrication into daily operations, carry out lubrication improvement projects, and realise the associated cost savings. As equipment and lubrication technology continue to evolve, regular review of the approach will help continue to focus effort and resources on projects that deliver greatest value.

LOOKING AHEAD

Modern power plant operators will continue to demand three things from a lubricant: improved system efficiency, reliable equipment protection and longer oil and equipment life.

With pressure on the power industry higher than ever, for many companies the demands of today often supersede the challenges of tomorrow.

Praveen Nagpal, *Shell Global Product Application Specialist*

Praveen is a Mechanical Engineer and MBA by qualification, with a working experience of 22 years in power engines. He is the Global Product Application Specialist for stationary power engine lubricants and is responsible for managing relationships with key power engine OEMs globally.

LINK
www.shell.com/lubricants.

DRIVING DOWN MAINTENANCE COSTS

There are many factors impacting maintenance expenditure, but a direct correlation can be seen, where all other factors remaining equal, higher quality lubrication leads to lower maintenance costs.

Achieving excellence in lubrication (product selection and management) can result in far more significant reductions to total maintenance costs than purchasing lubricants based primarily on product price.