UNLOCKING EFFICIENT, RELIABLE POWER

How lubricants can help increase productivity and reduce total cost of ownership for turbines, transformers and stationary engines.

FOREWORD

A message from Marcelo Goldberg, Shell Lubricants Global Sector Manager for Power

Globally, the demand for power is increasing, driven by a growing population, mass urbanisation, and rapid industrialisation of nations like China and India. The consequence for those in the business of power generation, transmission and distribution is a need to achieve greater productivity and reliability, in a challenging climate of stricter environmental targets, severe penalties for supply interruptions, tighter budgets and tougher operating conditions.

Many companies are already well aware that reducing Total Cost of Ownership (TCO) over the lifetime of machinery is key to extracting the best possible value from the investment. However, the impact of lubrication on TCO is too often underestimated[1].

According to an international industry study commissioned by Shell Lubricants, the savings opportunity is recognised but undervalued. 58% of companies recognise that lubricant selection can help reduce costs by 5% or more[2], but fewer than 1 in 10 (8%) realise that the impact of lubrication could be up to six times greater[3].

In general, the cost of lubricants accounts for less than 5% of a power generation company's total operational expenditure[4]. Yet Shell Lubricants believes lubrication can deliver significant business value through improved system efficiency; reliable equipment protection; and longer oil and equipment life.

When considering the potential savings, the definition we use for TCO includes costs related to lost production resulting from equipment downtime.

To quantify the cost saving potential with an example from the wind power sector; wind turbine insurance company, GCube Renewable Energy Insurance, reported that there are around 1,200 incidents of gearbox failure each year among the 175,000 geared turbines in operation worldwide. 76% of these breakdowns are related to bearing failure, and the insurance claims commonly range between $200,000 and $300,000[5]. By helping protect bearings against wear and guard against premature failure, lubrication has the potential to deliver huge cost savings.

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

This paper explores the cost saving potential of effective lubrication, with case studies to illustrate how power companies have successfully worked together with Shell Lubricants to lower TCO and improve productivity.

I hope you find it both informative and useful.

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. Costs include maintenance, labour, fuel.
3. Survey commissioned by Shell Lubricants and conducted by Edelman Intelligence, based on 121 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.
4. Source: http://s05.static-shell.com/content/dam/shell-new/local/country/aus/downloads/pdf/lubricants/power-engine-family-brochure.pdf
5. Reference Grinding Gearboxes - Global Trends In Wind Turbine Downtime Events, February 2015 Report.

CONTENTS

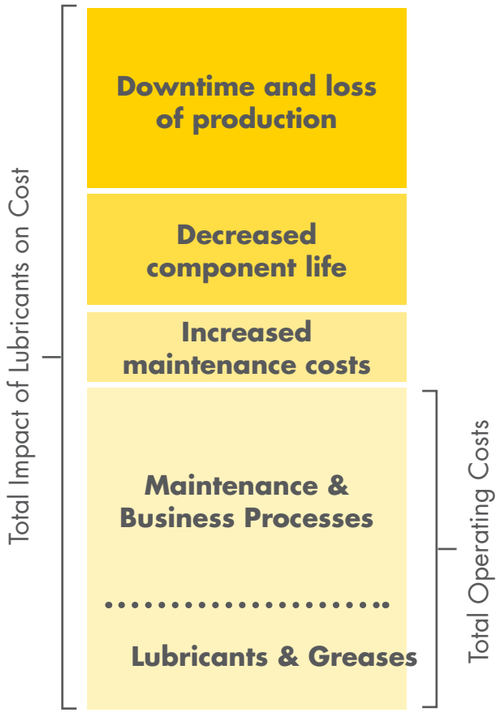
TOTAL COST OF OWNERSHIP: UNDERSTANDING THE POTENTIAL

Shell Lubricants believes that there is potential for lubrication to deliver significant business value by contributing to improved productivity and reduced costs. However, the potential impact of lubricants is often significantly underestimated.

Understanding how lubricants contribute to Total Cost of Ownership (TCO) is the first step to realising potential savings.

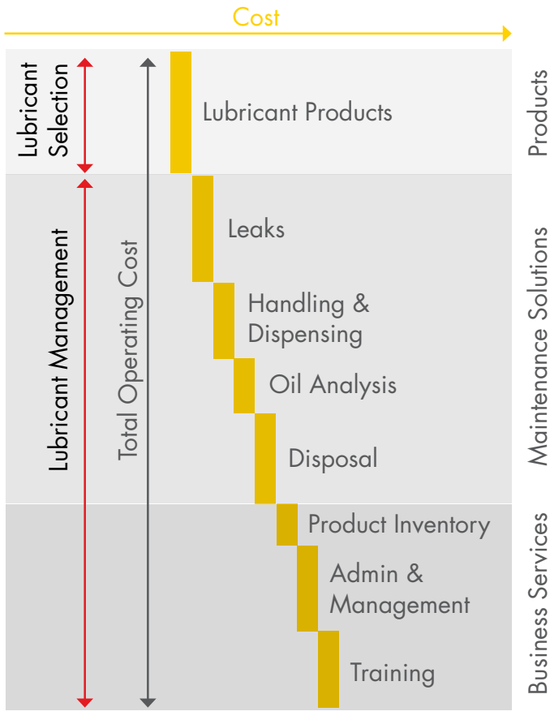
TOTAL COST OF OWNERSHIP (TCO)

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. Optimising lubrication can have a significant impact on component life, maintenance costs, and unplanned downtime, so it can contribute to cost savings far higher than the price of the lubricant itself.



THE IMPACT OF LUBRICATION IS UNDERRATED

58% of companies believe they can reduce costs by >5% through lubricant selection and/or management. Only 8% think savings could exceed 25%.[3]



SEIZING THE OPPORTUNITY

Lubricant product selection or management can impact many elements of a company's maintenance budget. Seizing the cost-saving opportunity depends on addressing two equally important elements:

1. Selecting the right lubricant or grease - the right product
2. Effective lubrication management – including the right storage & handling, the right place, the right time, the right amount, the right monitoring and the right people.

Shell Lubricants runs regular webinars with customers and experts in the power sector, to discuss pressing industry challenges and the trends impacting lubrication. These insights help identify where value can be unlocked through lubrication, and help inform the development of future products and services designed to help customers improve equipment reliability and reduce maintenance costs.

UNLOCKING SAVINGS AND PRODUCTIVITY IN THE POWER INDUSTRY

COMPANIES RECOGNIZE, BUT UNDERVALUE, POTENTIAL COST SAVINGS FROM EFFECTIVE LUBRICATION

56% of companies believe they can **reduce costs by >5%** through lubricant selection and/or management

savings >5%

But only **1 in 4** think savings could **exceed 10%**

In reality lubricants can impact up to **20% to 30%** of total maintenance expenditure[1]

POSSIBLE RELIABILITY AND PRODUCTIVITY IMPROVEMENTS ARE ALSO UNDERESTIMATED

Only **38%** believe effective lubrication can help improve **equipment availability**

41% understand how **improved wear protection** can result in cost savings

LACK OF LUBRICANTS EXPERTISE AND PROCESS ARE BARRIERS TO TOTAL COST OF OWNERSHIP[2] SAVINGS

The benefits of higher quality lubricants are not fully understood

60% do not expect it will help **reduce unplanned downtime**

49% do not expect it will help **reduce maintenance costs**

59% think they do not conduct **staff training** on lubricants as regularly as they should

Only **48%** think **lubricant product performance** should be an important purchase consideration

Only **43%** have all the **correct lubrication management procedures** in place[3]

THIS IS HAVING A FINANCIAL IMPACT

62% admit their incorrect lubricant selection has caused unplanned downtime

1 in 4 companies believe costs **exceeded $500,000**[4]

and **1 in 5** companies state costs **exceeded $1 million**[4]

EFFECTIVE LUBRICANT SELECTION AND MANAGEMENT CAN HELP COMPANIES LOWER **TOTAL COST OF OWNERSHIP (TCO)** THROUGH **REDUCED UNPLANNED DOWNTIME AND LOWER MAINTENANCE COSTS**

SHELL LUBRICANTS WORK WITH CUSTOMERS TO HELP DELIVER TCO SAVINGS

At least **$139 million** savings delivered to customers worldwide (2011-2015)[5]

260 Shell Lubricants technical specialists help customers reduce TCO through effective lubrication

260

OEM and customer collaborations enable Shell Lubricants to develop products that help improve performance, productivity and profitability

Shell Lubricants Services to help upgrade lubrication:

- Shell LubeAdvisor — Helping identify and seize savings
- Shell LubeMatch — Tailored product advice
- Shell LubeAnalyst — Lubricant monitoring
- Shell LubeCoach — Staff training

This survey, commissioned by Shell Lubricants and conducted by independent research firm Edelman Intelligence, is 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.

1. Potential impact calculated based on Shell Lubricants site surveys with customers.
2. 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.
3. Shell recommended procedures are delivery and storage, oil change, oil dispensing systems, efficiency of grease lubrication systems, oil analysis and training employees in lubricant selection or management.
4. $ figure based on converting local currency into equivalent $ amount.
5. Based on savings delivered to Shell Lubricants customers from 2011-2015.

SHELL LUBRICANTS
TOGETHER ANYTHING IS POSSIBLE

2

LUBRICANT SELECTION

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.

COLLABORATIVE INNOVATION

Collaborations with customers including OEMs and utility companies, help ensure that oils and greases are optimised for the latest equipment technology. Shell Lubricants works closely with a number of key OEMs to develop products that are technologically advanced and can meet and exceed equipment needs both now and in the future.

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LUBRICANT CHALLENGES

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

Below are some of the industry's primary applications and examples of specific lubrication challenges. In all cases, selecting the right lubricant is a critical first step in improving productivity and realising significant TCO savings

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 in order to accommodate fluctuating renewable power generation

BETTER FOR LONGER

The longer an oil resists degradation, the longer the oil and machinery can keep working. For turbines, Shell Turbo S4 X delivers exceptional resistance to degradation under conditions of high oxidative and thermal stress. In tests, it performed twice as well as the industry standard[7]. It also performs much better than other oils during the MAN-LTAT oxidation test (lubricant thermal ageing test).

WHAT DOES THIS MEAN FOR TURBINE OILS?

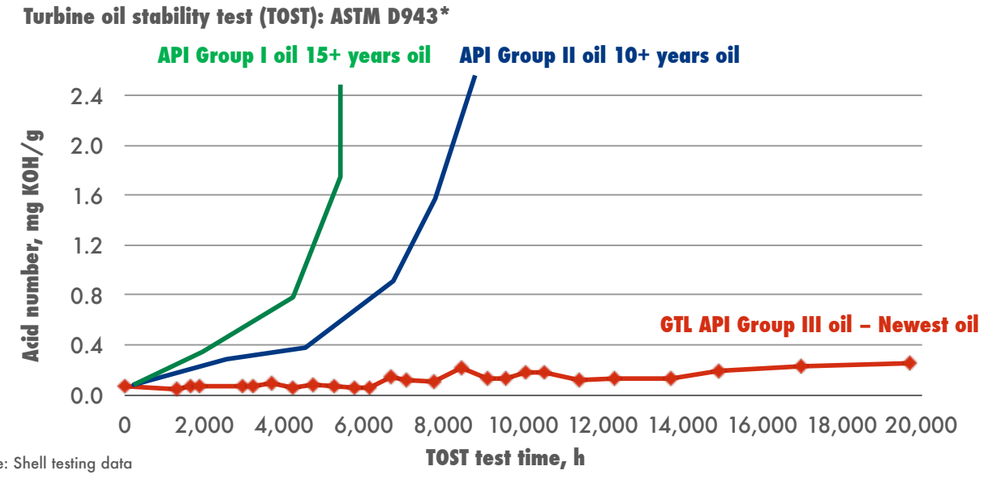
Modern turbine oils must be able to cope with increased stress and considerable operational challenges, including:

- Reduced downtime
- Extended oil drain intervals
- Higher temperatures and loads
- Frequent change of load; stop and start operations
- Greater output power but with a lubricant reservoir that is the same size or smaller, imposing more rapid cycle times on the lubricant with a consequent need for excellent surface properties.

They must also help enhance system reliability and efficiency by:

- Preventing metal-to-metal contact and controlling valve sticking during start up and shut down
- Cooling rotating parts quickly to prevent oil degradation and the formation of oil insoluble deposits
- Protecting against wear and corrosion of the main bearings and system components

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



*Source: Shell testing data

"Looking at the ratio of turbine megawatt output: oil volume, gives an indication of oil stress and we are seeing increases of up to 400% with the latest turbines. This is having a big impact on the types of lubricants required by power generation customers. At Shell Lubricants, we believe turbine oils made using Shell GTL technology hold the key to increasing productivity whilst helping keep the risk of costly equipment breakdowns to a minimum".

Dr Peter Smith,
Shell Global Technology Manager, Turbine 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[6].

The past decade has seen vast increases in size and capacity of both on and off-shore wind turbines. Tower heights now commonly reach 80-120m, rotor diameters average 95m 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:

- Increasing turbine blade lengths lead to increasing loads and vibration on bearings, which can cause increased wear.
- Turbines are 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 vital. In addition, the lubricant must resist the formation of harmful deposits and retain its wear protection properties when contaminated with water.
- The high flow rate for gear oils in a wind turbine gearbox (in cases 200L/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.

"Changes in equipment technology and design require ever more advanced wind turbine oils, greases and condition monitoring technology. The right lubricants, paired with the right lubrication management processes, can help improve wind turbine reliability and reduce unplanned maintenance, enabling wind farm operators to lower overall operating costs".

Dr. Felix Guerzoni,
Shell Lubricants Product Application Specialist

6. Source: Global Wind Energy Council, Global Wind Report, Annual Market Update 2014.
7. Shell test data vs. ASTM requirements.

"As a multinational utility company that owns almost 500 high-voltage substations, we have an acute interest in prolonging the lifespan of our transformers and maximising their reliability, as this helps us to provide the best value to our customers while ensuring they get the electricity they need. We know that the oil we use plays a vital role in this".

Gordon Wilson,
Technical Specialist in Insulating Liquids,
National Grid plc

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.

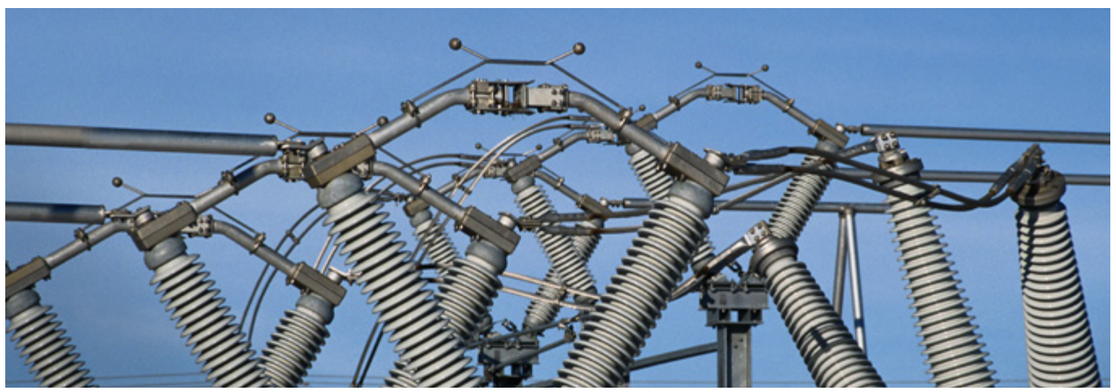
Stresses on lubricants have increased:

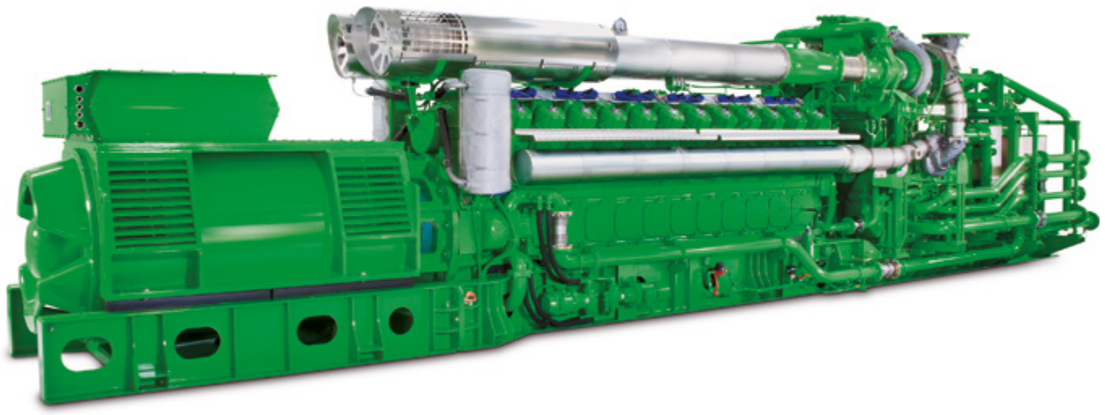
- Many transformers frequently operate under overload, with larger voltages to improve transmission efficiencies and higher power:weight or power:volume ratios to reduce manufacturing and installation costs.
- This means transformer oils must work effectively for longer and in higher temperatures.
- They must also protect against copper corrosion, paper degradation and premature oil ageing.

STATIONARY ENGINES

While the latest engines, such as natural gas engines, deliver greater efficiency they pose challenges for the lubricant. The use of non-conventional fuels – such as landfill, bio or sewage gas – in stationary power generation engines also pose challenges for lubrication:

- Key among these is the increased risk of ash deposit build-up in the combustion chamber due to siloxanes; and corrosion resulting from the presence of halogenic compounds and acidic elements in the gas. Higher levels of oxidation and nitration products also significantly increase the acid stress and can shorten the oil's life.
- Lubricants need to protect the engine and extend equipment life by neutralising acids produced during combustion or by the oxidation and nitration of the oil itself. Lubricants should have a low-ash content to minimise deposit build up.
- A balance between ash level and performance has to be made 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 can lead to wear and deposits.





"The use of gas fuels in engine-based power generation is a fast-developing sector. Often, plant operators are forced by their procurement departments to select cheaper lubricants to try to minimise operational costs. But this actually means purchasing products that may affect the reliability of the engine and reduce its lifespan. Lubricant product selection should be always based on a well-considered TCO calculation, rather than price alone".

Praveen Nagpal,
Shell Global Product Application Specialist

IMPROVING RELIABILITY AND LOWERING COSTS WITH HIGH QUALITY LUBRICANTS

By selecting a high performing oil or grease, power sector companies can realise TCO savings that reach far beyond any savings related to the price of the oil or grease itself.

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 quality lubricant that keeps equipment clean of deposits, retains good miscibility (the ability to mix compatibly with other liquids) and effectively protects against wear and corrosion can help extend equipment life, reduce frequency of breakdown and increase equipment availability.

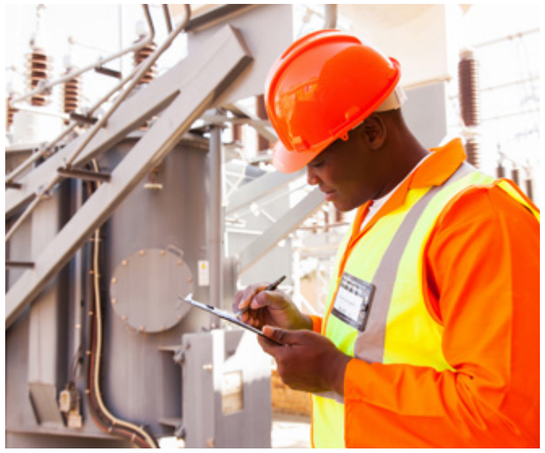
This could significantly decrease spend on spare parts and maintenance.

CASE STUDIES

The following case studies demonstrate how Shell Lubricants has worked with power companies to support them in selecting high quality lubricants to help generate substantial cost savings.

LUBRICATION CAN SIGNIFICANTLY INFLUENCE EQUIPMENT RELIABILITY

But 60% of companies wouldn't expect higher quality lubricants to result in a reduction in unplanned downtime[3].



INDIAN CNG SUPPLIER EXTENDS OIL DRAIN INTERVALS BY 68% AND BOOSTS EQUIPMENT AVAILABILITY, SAVING USD $84,333[8]

The challenge

Indian supplier of compressed natural gas (CNG) Indraprastha Gas Ltd (IGL) uses more than 130 gas engines from manufacturers such as Caterpillar and Waukesha to drive the compressors at its CNG outlets across Delhi, India. The engines operate in temperatures ranging from 2 to 46°C. The lubricants IGL was using had oil-drain intervals of between 750 and 850 hours, and were looking to extend this in order to achieve cost savings.

The solution

Shell Lubricants technical experts suggested that IGL trial Shell Mysella S5 N – a product specially developed to provide extended oil-drain intervals in those natural gas engines where oil life was a limiting operational factor. The trial was supported with Shell LubeAnalyst oil condition monitoring service. The Shell Lubricants technical experts also demonstrated the Shell VideoCheck service, which uses a flexible videoscope to enable engineers to look inside an engine to inspect for deposits or evidence of wear.

The results:

- As a result of upgrading to Shell Mysella S5 N, the company has increased the oil-drain intervals by 68%, to 1,100 hours.
- This helped to reduce oil consumption and labour costs and increase filter life and equipment availability
- The company reported total annual savings of US$84,333

8. 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

SOUTH AFRICAN ELECTRICITY COMPANY SAVES $170,000 FROM REDUCED MAINTENANCE COSTS AND DOWNTIME[8]

The challenge

South African electricity company Eksom wanted to improve operating efficiency at its power stations. The company was using a mineral oil to lubricate the fan gearboxes and was considering the benefits of switching to a synthetic oil.

The solution

Shell Lubricants technical experts recommended that Eskom trial Shell Omala S4 GX, an advanced, synthetic industrial gear oil, in the 13 gearboxes at one of the power stations. This advanced, heavy-duty, synthetic industrial gear oil offers excellent lubrication performance under severe operating conditions, including reduced friction, long service life and high resistance to micropitting for optimal gear protection. The company also decided to take advantage of the Shell LubeExpert specialist technical support service.

The results:

- By switching to Shell Omala S4 GX, Eskom found that the operating temperature of the gearbox had reduced to 69–73°C compared with 73–80°C when using the mineral oil at similar loads.
- The results of the trial showed that Shell Omala S4 GX, in combination with improved lubrication practices, provided energy savings of between 2.2 and 3.8%.
- The company also benefited from extended oil-drain intervals, lower lubricant consumption and longer component life, enabling them to reduce operational downtime and maintenance costs.
- The company reported a total annual saving of US$170,000

TRANSFORMER MAINTENANCE COMPANY SAVES USD $24,000 BY UPGRADING TRANSFORMER OIL[8]

The challenge

German company L&Z Transformatoren (L&Z) specialise in the maintenance, recovery and disposal of electrical power systems. A core service is the purification and re-conditioning of transformer oils. They had used conventional transformer oils since 1984, and found that when re-conditioning the oil it tended to foam during the vacuum treatment process, requiring the maintenance process to be halted whilst the foam dissipated. L&Z contacted Shell Lubricants for advice on reducing the processing time to improve efficiency.

The solution

Shell Lubricants technical experts conducted a complete process review and introduced Shell Diala S4 ZX-I, which has a much lower foaming tendency than conventional transformer oils.

The results:

- The company reported a saving of USD $24K per year due to reduction of time taken for maintenance process
- Estimated maintenance time saving of 10% due to the lower foaming tendency of Shell Diala S4 ZX-I
- Increased system availability, improving the attractiveness of L+Z's service to their customers

"Reducing costs and increasing maintenance intervals was essential for our business. Working with Shell Lubricants, we have been able to save approximately 10% of the time taken in the process which has a tangible cost saving." - Lead Engineer, L&Z Transformatoren".

Lead Engineer,
L&Z Transformatoren

LUBRICATION MANAGEMENT

Even the best product cannot perform effectively if it does not reach the right surfaces at the right time, in the right amount, without being contaminated or degraded.

Effective lubrication management is vital to unlock potential TCO savings. It helps deliver value from improved productivity and reductions in lubricant consumption, maintenance and operating costs.

SHELL LUBRICANTS' SIX STEPS TO GOOD MANAGEMENT OF OILS AND GREASES

1 **RIGHT STORAGE & HANDLING**
oils and greases must be stored in the right conditions and handled correctly to avoid contamination and preserve its key characteristics.

2 **RIGHT PLACE**
For the oils and grease to reach the right surface it 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.

DID YOU KNOW?

Shell has one of the world's largest teams of technical lubricants experts. The 260-strong team of Shell Lubricants technical specialists, supported by distributor partners, provides a suite of lubrication management services across various industries.

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CHALLENGES AND SOLUTIONS

The following examples are two of the main lubrication management challenges commonly faced by power companies, the importance of taking action to address these, as well as the available Shell Lubricants Technical services to support.

SHELL LUBEANALYST DATA SHOW THAT 30% OF HYDRAULIC SYSTEMS HARBOUR IMMINENT OR INCIPIENT FAILURES.

The challenge
Right storage and handling

Contamination control is critical to maximising the performance of the lubricant in equipment. How the oil or grease 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.

The solution
Expert advice and staff training

Underpinning good lubrication management practices is industry knowledge and expertise. One of the core lubrication management services offered by Shell Lubricants is building technical competency across a customer's organisation. This is delivered through Lubricant Technical Advisors, supported by a team of Global Product Application Specialists and Lubricants Services Experts. They are a regular presence on-site, sharing expertise to help customers implement effective lubrication management procedures.

The challenge
Right Monitoring

Regular monitoring and analysis is critical to ensure the lubricant or grease is functioning well and remains fit for purpose.

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

The solution
Oil Condition Monitoring Service

Shell has one of the world's largest teams of technical lubricants experts. The 260-strong team of Shell Lubricants technical specialists, supported by distributor partners, provides a suite of lubrication management services across various industries.

TRAINING AND PROCESSES FACILITATE EFFECTIVE LUBRICATION

59% of companies admit they don't conduct staff training on lubricants as regularly as they should, and only 43% have all the recommended procedures in place to manage lubricants effectively*[3]

*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

EXTERNAL SUPPORT CAN PLAY A VALUABLE ROLE IN UPGRADING LUBRICATION MANAGEMENT TO ACHIEVE COST SAVINGS

But only 1 in 4 companies (25%) currently have regular visits from technical staff from their lubricant supplier[3].

"A common mistake is reducing ODIs even though the condition of the oil or grease remains satisfactory. Implementing an effective lubrication monitoring programme can allow plant managers 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.

Praveen Nagpal,
Shell Global Product Application Specialist

DELIVERING BUSINESS VALUE THROUGH LUBRICATION SERVICES

Shell LubeAnalyst

LUBRICANT ANALYSIS

A global oil and equipment monitoring service that helps customers assess lubricant condition, identify potential problems, and benchmark equipment performance against comparable oil samples from around the world. Available in 95 countries and 28 languages, it has more than 60,000 users worldwide, and analyses over 750,000 samples a year. The service allows customers to monitor equipment without interrupting operations, and provides guidance on interpretation of results.

Shell LubeAnalyst Lite

RAPID ON-SITE ANALYSIS

Shell LubeAnalyst Lite[9] on-site analysers deliver fast, comprehensive test results for machine lubricants including engine and gearbox oils, hydraulic fluids and power steering and transmission fluids. Maintenance staff can test lubricants on-site at any remote location and get results within 15 minutes. The service can help limit downtime and lower maintenance costs by capturing early signs of abnormal wear, and helping extend oil-drain intervals.

Shell LubeCoach

UPSKILLING EMPLOYEES

A customised training programme, led by Shell technical experts with substantial in-field experience, which offers practical coaching to customers' staff on lubricant management techniques.

Shell LubeAdvisor

IDENTIFYING AND SEIZING VALUE OPPORTUNITIES

Specialised Shell Lubricant Technical Advisors (LTAs) conduct site surveys to help customers identify areas for improvement in lubrication. All stages of the lubrication process are addressed, including product selection, delivery, storage, distribution across the site, product application and disposal of used lubricants. Changes are implemented and measured through 'Value Improvement Projects'.

The Shell LubeAdvisor service has recently been upgraded to include a 24-hour virtual assistant service offering troubleshooting support to customers.

Shell LubeMatch

TAILORED ADVICE

An easy-to-use online service that recommends the right choice of engine oil and lubricant for specific applications. It provides jargon-free guidance on the benefits of different lubricants. It is available in 120 countries and 26 languages, making it the most comprehensive and integrated lubricant selection tool on the market. The service receives 2.5 million visits per year.

9. Shell LubeAnalyst Lite complements the off-site, laboratory-based service offered by Shell LubeAnalyst. Shell LubeAnalyst remains the recommended analysis service when extreme precision is more important than fast results. Shell LubeAnalyst Lite is not currently available in all regions.

UNLOCKING VALUE

Over the last five years, Shell has delivered $139 million in documented savings to customers worldwide[10]. These savings indicate the potential for lubrication excellence to deliver TCO reduction and productivity increases.

The following case studies demonstrate how Shell Lubricants technical experts have worked together with companies to help upgrade lubrication management processes and generate substantial cost savings[11].

SMARTER LUBRICATION SAVES POWER COMPANY USD $27,000 PER YEAR[11]

The challenge

Pakistani power company, Anoud Power Generation, operates Caterpillar G3520C gas engines. The lubricant product being used, from another manufacturer had an oil-drain interval of 3,000 hours. The company wanted to extend the oil drain interval to reduce costs and asked Shell Lubricants for advice.

The solution

Shell Lubricants technical experts suggested the company switch to the high performance Shell Mysella S5 N gas engine oil and take advantage of the Shell LubeAnalyst oil and equipment monitoring service. By analysing the results, Anoud Power Generation found that it could extend oil drain intervals to 3,600 hours without compromising engine protection.

The results:

- Oil drain interval extended by 20%
- Reduced lubricant and filter consumption
- Lower maintenance time for oil changes
- Total reported annual savings of USD $27,000

TURBINE OIL UPGRADE PLUS OIL CONDITION MONITORING SERVICE SAVES STEEL PRODUCER USD $57,088[11]

The challenge

One of the largest steel producers in China, Jiangsu Shagang Group (Shagang), experienced problems in its power plant steam turbines just a few months after commissioning the new equipment. The company 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.

The solution

Following a review of the turbine lubricant system, oil analysis data and discussions with site management, Shell Lubricants technical experts proposed ways to improve turbine reliability. This included switching to Shell Turbo T 46 turbine oil, adopting the Shell LubeAnalyst oil condition monitoring service, fitting improved seals to prevent steam ingress, and implementing regular draining of water from the bottom of the lubricant tank.

Shell Turbo T 46 turbine oil was recommended for its robust demulsibility control, which means excess water can be easily drained from the steam turbine lubrication system, helping to minimize corrosion and premature wear, and lower the risk of unplanned maintenance

The results:

- Technical support provided by Shell Lubricants as part of the Shell LubeExpert service helped Shagang to improve its seal design, scheduled maintenance activities and contamination control.
- Upgrading to Shell Turbo T 46 helped to reduce journal-bearing failures, extend bearing life, prolong steam turbine oil life and improve turbine availability.
- As a result, the company reported annual savings of USD $57,088

10. Documented customer savings from 2011 to October 2015. More information available upon request.
11. 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.

REALISING VALUE

A STRUCTURED APPROACH TO UPGRADING LUBRICATION

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

- Senior management support of the TCO-driven approach to lubrication, to help overcome challenges such as resourcing alongside the demands of daily operations.
- Appointing a project lead and allocating appropriate time and resources to a team tasked with implementing changes.
- A good relationship with the lubricant supplier, whose technical teams play a key role in identifying and delivering value.
- A comprehensive analysis to identify, quantify and prioritise TCO-related projects. Importantly, aligning on how value is measured enables savings to be recorded accurately.

For example:

1. What is the hourly cost of maintenance and time required for repairs?
2. What is the cost of replacement parts?
3. What is the benchmark failure frequency?
4. What is the monetary value of downtime for each piece of equipment, in terms of lost production?

- Setting measurable targets to ensure that progress can be tracked.

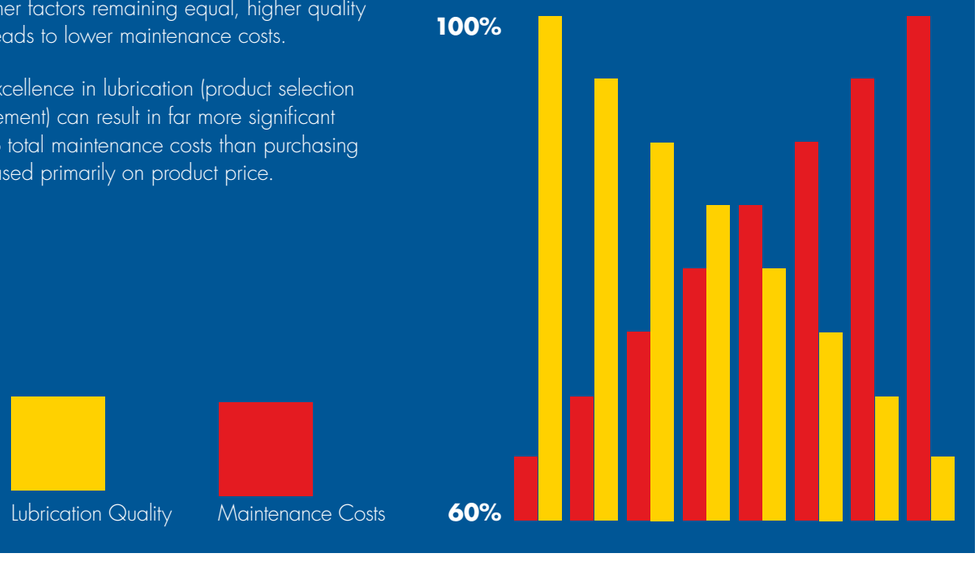
These steps will help companies form a strong foundation from which to successfully incorporate a TCO-driven approach to lubrication into daily operations, carry out lubrication improvement projects, and realise the associated cost savings.

As equipment and lubrication technology continue to evolve, regular review of the approach will help companies continue to focus effort and resources on projects that deliver greatest value.

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.



WHAT'S NEXT?

Modern power plant operators will continue to demand three things from an oil or grease: 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.

For Shell Lubricants, helping customers reduce TCO in the present day is the first step. Equally important is looking ahead to identify the next generation of lubrication products and services that will continue to give companies a competitive edge.

Examples of current industry trends and issues Shell Lubricants is already addressing include:

ALTERNATIVE FUELS

Driven by tightening emissions regulations, the use of non-conventional fuels like bio and sewage gas is increasingly commonplace. This presents a raft of compatibility and performance challenges for lubricants.

REAL-TIME MONITORING

Applying sensor technology to enable real-time analysis of lubricant and equipment performance will play an increasingly important role in lubrication management.

RENEWABLE POWER

A shift is already underway towards renewable energy, such as wind power. However, renewables also bring new, more demanding operating conditions for lubricants.

TECHNICAL INNOVATION

Gas-to-liquid (GTL) technology is one of the most exciting recent innovations in lubrication and could enable significant performance improvements and cost savings for customers. We expect GTL-based lubricants to be central to the power generation industry in the future.

APPENDIX

LUBRICANTS TECHNOLOGY – KEY FACTS

FOUR 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:

REDUCE FRICTION
Lubricants form a fluid barrier between moving surfaces. This reduces friction between them, helping maintain smooth running and limit wear.

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.

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.

COOL
Lubricants absorb excess heat from high temperature zones and transfer it away for cooling. This allows the equipment to function efficiently.

DID YOU KNOW?

The latest synthetic base oils from Shell are produced from natural gas using a proprietary gas-to-liquids (GTL) process. With no sulphur[12] 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.

LUBRICANT FORMULATION

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 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.

BASE OILS AND ADDITIVES

Base oils typically make up from 75% to over 99% of the finished product, depending on the lubricant type, and influence many of its key characteristics.

The additives comprise anything between 1% and 25% of a lubricant's composition, depending on the finished product, and work to enhance key performance aspects of the base oil, to achieve optimum performance of the finished product.

Benefits can include:

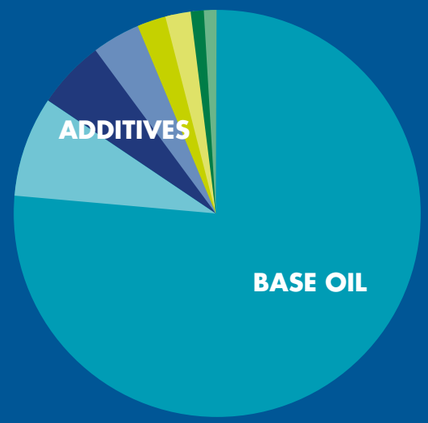
- Protection against wear to help extend component life and reduce maintenance costs. This is delivered through: anti-wear additives that prevent metal-to-metal contact and control valve sticking; extreme pressure agents that separate metal surfaces at high pressure; and sometimes solid fill additives that protect against shock loads at low speeds.
- Operating performance, delivered through detergents and dispersants that help manage the accumulation of soot and other impurities. This helps avoid abrasive wear that can impair equipment performance.
- Reduced cost of lubrication as a result of longer oil or grease life. This is achieved through anti-oxidants that help the oils deal with higher temperatures and loads, prevent corrosion, and guard against lubricant breakdown

12. Below the detection limits according to ISO 14596/ASTM D262.

EXAMPLE COMPOSITION OF A LUBRICANT: BASE OIL AND ADDITIVES

BASE OILS
different viscosity grades, blended to the right viscosity

ADDITIVES
- Detergents + Acid neutralisation – together form over-based detergent
- Extreme pressure + Anti-wear
- Anti-oxidants
- Anti-foam
- Demulsifier
- Dispersant



GREASE THICKENERS

Greases are designed to release lubricating fluid under pressure and then reabsorb it. The life of the grease is determined by its ability to do this without changing consistency – its mechanical stability.

The thickener is a key component of a grease, which determines its basic properties (such as bleeding rates, oxidation and mechanical stability) and impacts its quality. In most industries, lithium or lithium complex thickeners are used for the majority (~80%) of all applications. These deliver good water resistance, excellent mechanical stability, corrosion resistance, and good performance at low and high operating temperatures.

PARTNERING FOR INNOVATION EXCELLENCE

Committed to delivering value to customers, Shell invests significant resources in developing new lubricants for the power industry.

A network of collaborations strengthens the innovation capabilities of Shell Lubricants Research & Development teams located in Technology Centres in Shanghai, Hamburg and Houston.

- Technical Partnerships with customers including OEMs and utilities help steer the development of oils and greases for the latest equipment technology.
- Field trials with customers validate performance in real-life scenarios and demonstrate how products can help improve equipment performance, efficiency and reliability.
- Shell Lubricants products for power equipment are approved or meet the specifications of many leading equipment manufacturers, including: Siemens; MAN Diesel and Turbo; Rolls-Royce; Wärtsilä; and GE.
- Shell and the University of Manchester in the UK collaborated in a major European research consortium investigating transformer design and operation and the influence of the oil on ageing and reliability characteristics. This programme has the potential to help revolutionise the lifespan of transformers in the future.

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