LUBE-TECH

NO.18

AUTOMATED LUBRICANT MAINTENANCE

When I started in the lubricant business planned maintenance was the order of the day, times have changed now we have automated lubrication systems, which solve many of the problems caused by erratic lubrication by those charged with oiling machines and lubricating the plant of a particular factory. Modern centralised lubrication systems using high-pressure pumps, metering devices accurately deliver lubricants to individual machines. Looking forward, latest technology proclaims that the future for preventive and routine maintenance is condition monitoring, and I am sure that once industry's financial directors become aware of the potential financial benefits for their operations, they will want, perhaps insist, that those staff involved investigate how they introduce the concept for their plant. Condition monitoring includes checking a machine's other critical factors as well as lubrication and typically includes such parameters as temperature, vibration, alignment, balancing, and process information.

For end-users who wish to know more about the case for using automatic lubrication systems I think you will find the financial case is well made in the following article from Interlube Systems Ltd

BEARINGS BENEFIT FROM AUTOMATIC LUBRICATION

Although fleet operators cannot avoid spending valuable time and money on vehicle maintenance, automatic lubrication provides them with a means of bringing the costs down.

As vehicle purchase and running costs mount, the vehicle owner/operator and fleet and maintenance manager place a deal of importance on the time spent by trucks and buses on the road; this as opposed to that spent standing idle in repair workshops, while worn chassis bearings are replaced. The utilisation of automatic lubrication keeps commercial vehicles in full working order and, therefore, helps businesses cut costs. With new vehicle costs as high as £67,500 for a 38-tonne tractor and trailer unit (26,000 for a 7-tonne vehicle) it is obviously the fleet manager's responsibility to ensure that the vehicle works its full quota of hours. Any less and it does not generate an acceptable level of profitability. Non-working time and workshop costs are obviously two of the fleet manager's greatest concerns. They must juggle the need for both vehicle profitability and effective maintenance. Estimates show that during its working life, an average 8x4 tipper will require two replacement sets of both king pins and shackle pins, and one set of brake camshafts, track rod ends, drag links, brake adjusters, and so on. All of this comes at a material cost of approx. 5,500. However, this figure does not include labour. A typical rear tipper system, for instance, costs 1,200. All in all, an operator must expect a vast total outlay.

MANUAL VS AUTOMATIC LUBRICATION

Manufacturers are always asked, why is replacement necessary? Why don't bearings last the life of a vehicle? In essence, the answer to these questions lies in the unreliability of periodic manual lubrication.

In contrast, experience shows that with automatic lubrication, a component's working life is extended by up to five times.

Effective component lubrication can help fleet operators maintain the delicate balance between profitability and essential maintenance costs.

Manual lubrication must be carried out whilst the vehicle is stationary. Therefore, even under high pressure pumping, it is extremely difficult to force grease into a close-fitting bearing - its surfaces being in close contact with each other and under the weight of a vehicle. As a result, there is frequently a lack of effective protective lubricant between the working faces, which heightens the risk of greatly accelerated wear. Therefore if a manually lubricated truck is working long hours on motorways or on uneven country roods - with suspension points under constant pressure - bearing wear quickly sets in. Inevitably, components must be replaced.

Added to the cost of repairs is that of manual lubrication. Assuming that one hour's work per month is equal to £25, a six-year period would amount to a total cost of £1,800. In reality, companies are incurring costs (in excess of £700) that could be avoided if an automatic lubrication system were to be implemented. When taking into account standing costs that accumulate over 106 hours (a six-year period) at a typical rate of 30 per hour, a further 3,180 is brought into the equation.

Based once again on the average 8x4 tipper, the cost of an automatic system is substantially lower than that of manual labour. Not only that but with a payback period of less than one year, automatic lubrication makes sound economic sense.

Despite the obvious financial rewards, well-lubricated chassis and suspension bearings provide the operator with the additional benefits of easy steering, improved ride characteristics and reduced driver fatigue, in terms of safety, braking efficiency and safety are also maintained of a high level if the braking system is correctly lubricated. If, after accident damage, components must be replaced, the task becomes easy if they have benefited from efficient and constant lubrication - it has even been proven that the utilisation of automatic lubrication can enhance vehicle re-sale value.

So I am sure you will agree that the case has been made for automatic lubrication of vehicles and their ancillary equipment. The same line of reasoning applies to virtually every type of machine or factory that uses machines, which need regular lubrication and to companies who want to save money and increase productivity.

The equipment and system providers have many different solutions on offer to ensure that cost effective and efficient use of resources are employed by end-users to achieve the desired correct lubrication of machinery.

MAIN TYPES OF AUTOMATIC LUBRICATION SYSTEMS

- Single-line injector systems
- Single-line progressive systems
- Two-line systems
- Multi-line systems
- Multi-outlet micro-processor controlled systems
- Positive displacement plunger systems
- Oil re-circulatory systems
- Oil-spray mist and non-mist systems
- In-line proportionally mixed water/oil emulsion spray systems
- Self-contained individual automated lubricators

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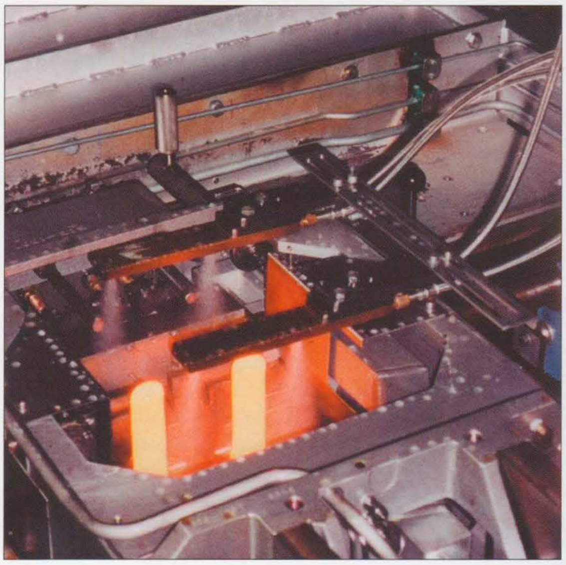

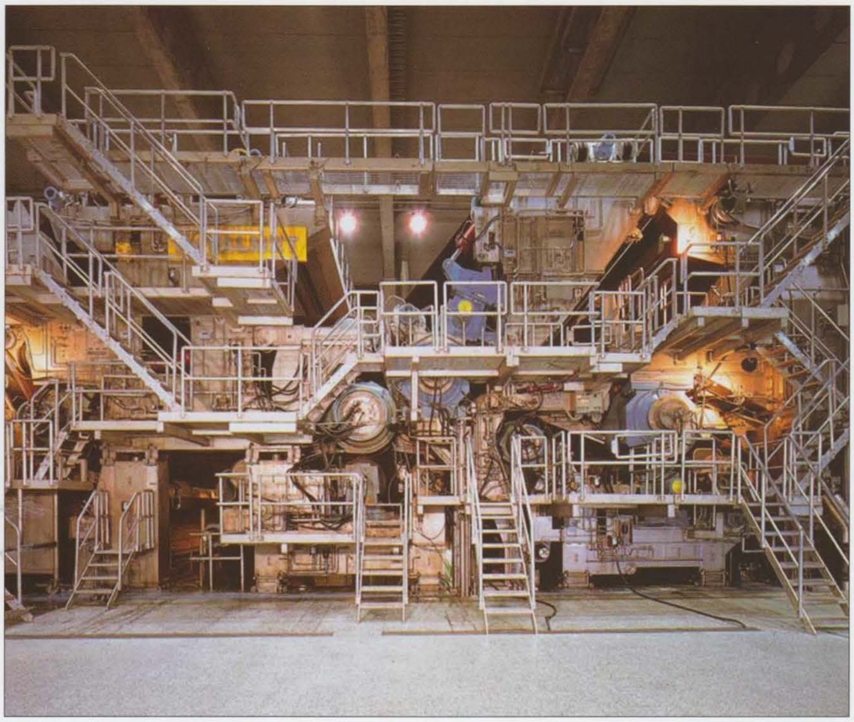

The systems on offer can be adopted to use many different types of lubricant: -oils, both neat and controlled water/oil emulsions, greases and synthetics oils, and accurately dispense regular controlled lubrication to ensure correct maintenance is carried out. They reduce down time, reduce faults and mechanical failures, whilst using lubricants in a more cost-effective way. It'is a win-win situation.

I have found that UK suppliers of these systems have the expertise and people to tackle the most complicated requirements and they offer a range of services specifically targeted to ensure they meet end-users prime requirement of saving money, improving productivity and reducing oil consumption.

I have included at the end of the feature details of a number of suppliers and their contact points who are manufacturers and supplier of the various types of equipment mentioned. These companies have assisted in my research for the preparation of this feature.

For illustration purposes I have included photographs of examples of the many different types of automatic lubricators.

CONDITION MONITORING

Thorough our industry contacts we are aware that this concept is becoming the new way forward for trouble free operation and maintenance of machinery.

SKF have been in the vanguard of these developments and they have just announced the introduction of another novel solution to monitoring a multi-machine situation called **Machine Analyst™**. The following article sets out a summary of its operation and benefits.

After nearly a century of experience with customers from all industrial segments, SKF has become intimately familiar with industry-specific business processes and challenges. The company's vast array of product and service solutions assists customers in achieving optimum performance of plant machinery to enable machines to not only run reliably, but run better, faster and longer.

The latest development from the company, 'Machine Analyst™ is the core platform in a family of reliability software applications that work together as 'SKF Machine Suite'. Machine Analyst harnesses the power of today's leading software development technologies and capabilities, including advanced software architecture, programming design standards and a state-of-the-art database management system, to bring a software solution to machinery optimisation that is second to none.

It also provides a means to incorporate lubricant, temperature, thermographic, alignment, balancing, and process information for comprehensive machine analysis, documentation and reporting.

The system's open architecture makes it easy to more rapidly respond to customer requests for enhanced application features. In addition, it ensures that customers obtain the utmost value from their program by enabling the development and integration of their own internal solutions, quickly and easily. By applying the power of Machine Analyst™, along with the full range of technology and service solutions, and integrating their own maintenance and management processes, customers will benefit from this comprehensive programme which reduces costs, improves productivity and increases bottom line profitability.

As a Windows™ 2000 and NT 4.0, 32-bit application, Machine Analyst™ benefits from both the stability of this platform and the time savings gained from users working with an instantly recognisable interface. All the features are easy to use and customise for the unique requirements of individual users. Windows™ straightforward editing features extend to all aspects of Machine Analyst's functionality, including database set-up, which is quick and easy, letting users cut, copy and paste portions of the database hierarchy into another section of the database. As a result, the setting-up of a new machine can be accomplished through simply copying and pasting point set-up information to the new machine template. Similarly, the editing or modifying of alarms is made easy by Windows™ drag and drop, which allows alarms to be moved to new locations, with Machine Analyst automatically changing the numeric settings accordingly.

The Oracle, 8i™ relational database used by Machine Analyst provides network efficient client-server architecture and is regarded as today's leading database management solution. It enables Machine Analyst to manage all types of decision related information and fully supports Open Database Connectivity (ODBC) and Structured Query Language (SQL). This provides fast, efficient and reliable storage, manipulation and retrieval of virtually unlimited complex machine and plant information to provide the most accurate and complete portrayal of plant assets.

Utilising Microsoft's Component Object Model architecture (COM), Machine Analyst is easily and effectively integrated with third-party plug-ins, as well as important plant-wide systems, such as Computerised Maintenance Management Systems, Enterprise Resource planning and others. COM facilitates the compilation and correlation of data from a wide variety of plant information and vibration monitoring systems, including portable data collectors, on-line and wireless systems.

I would like to record my thanks for help in putting this feature together, from Chris Welch of Interlube Systems Ltd; Phil Burge of SKF (U.K.) Ltd.; Paul Connolly of Lincoln Industrial; Alan Fryer of MSP Distibutors Ltd; P Shiel of Allube of Sheffield and Lincoln Brown of Graphoidal Developments Ltd.

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WHAT YOU NEED TO KNOW ABOUT MICROPITTING

The design of machinery and mechanical equipment is subject to constant change and improvement, and developments such as computer-simulation technology and other techniques enable design engineers to tailor machinery design more and more closely to meet performance requirements with the minimum of over-design, and with the minimisation of the associated manufacturing costs. A century ago, civil and mechanical engineers would build in 'safety factors' of 200% or more, thus ensuring reliability in service, and achieving operating lifetimes which far exceeded the requirements anticipated at the time of construction. In our increasingly competitive manufacturing environment, such excesses can no longer be tolerated.

With improvements in materials, manufacturing processes and design technology, excessive 'safety factors' have been progressively reduced over the years, with consequent reductions in build costs. In the vast majority of cases, reducing these safety factors has been achieved without compromising safety or operational performance. There are exceptions, however, since such progress is always subject to the occasional hiccup, where problems in use occur which had not been anticipated during the design stage, or where previously unforeseen problems emerge. Typical of the former is the situation of the much publicised 'swinging' footbridge over the river Thames; an example of the latter is the comparatively recent phenomenon known as 'micropitting'.

The term micropitting, whilst accurately describing the phenomenon, should not misinterpreted as implying that that the problem is small-scale, and therefore relatively easily to overcome. This is most definitely not the case; micropitting, for example, has caused premature failure in fit-for-life marine gearboxes which has entailed cutting holes in the sides of ships, or removing much of the upper decks together with the associated superstructure, in order to replace failed gearboxes. Repair and rectification costs of such major mechanical failures are daunting enough in commercial situations involving passenger and cargo shipping; even more serious are situations involving military equipment, such as warships, submarines, etc., which have been subject to such catastrophic failures in action, necessitating premature return to docks for repair.

WHAT IS 'MICROPITTING'?

Micropitting is a form of metal wear, visible only under microscopic examination, which consists of a series of shallow cracks, some of which can be as little as 10? in size. As the extent of the pitting increases, the degradation can subsequently be visualised as a dull matt area, resembling the appearance of etched glass. Sometimes, the degradation self-arrests at this stage, without causing any further damage. All too often, however, micropitting then leads to macropitting, with associated formation of deep fissures and loss of metal. Catastrophic failure can then follow. Even the development of 'arrested' micropitting is not necessarily without its problems, since this situation can still be responsible for loss of gear mesh accuracy, with an associated increase in vibration and noise. Also the small metal particles released into the lubricant are too fine to be filtered out by conventional barrier filters, but can still cause longer-term damage to gear teeth and other bearing surfaces.

WHERE DOES IT OCCUR?

Micropitting tends to occur mainly in heavily-loaded, case-hardened gear systems, such as those used in marine gearboxes, or those for wind turbines such as pictured on the front cover of this edition of 'LUBE'. Wind turbines, in particular, present a challenging situation, since they are subject to constant variations in loads and speeds, due to changing weather conditions and wind velocities. Problems associated with the onset of micropitting have also been encountered in such diverse situations as plastic extrusion equipment, rubber kneading equipment, high-speed turbines and bucket excavators.

As already mentioned, the constant quest for higher efficiencies, smaller and lighter components, reduced material and manufacturing costs, etc., have all resulted in a general increase in localised stress levels on component items, revealing problems which had not previously existed or had been anticipated.

Individual factors which have been identified as influencing the formation of micropitting include methods of component manufacture, surface hardness, hardening processes, finishing processes, residual stresses in components, surface finish, form errors, contact stress, alignment, speed, vibration and, last but not least, lubrication.

THEORETICAL CONSIDERATIONS

The mechanism of lubrication of smooth surfaces such as those found in rolling element bearings is a relatively straightforward elastohydrodynamic lubrication (EHL) situation, which is well understood. A very different situation exists when considering the lubrication of gear teeth, since in this case, the surface roughness of the finished components, even on high quality gears, is large compared to the thickness of the lubricant film. As a result, localised breakdown of the fluid film can result in isolated areas of dry contact that can only be protected by boundary lubrication, and the load is then shared between these micro-contact lands, and lubricant present in the 'valleys' between the asperities. Under these conditions, the lubricant is subject to very high pressures, which in turn results in changes to the micro-behaviour properties of the lubricant, the performance of which under these conditions can only be predicted by suitable mathematical models. The establishment of mathematical models which predict the behaviour of the lubricant in such circumstances is complex problem which has been studied at a number of academic institutions, including University of Wales -Cardiff, Newcastle University, and DERA, Pyestock, over a number of years. Work programmes at these various academic seats of learning has centred on defining lubrication characteristics of different rough surfaces in rolling/sliding contacts with the intention of establishing quantifiable parameters that can predict the likelihood of the development of the type of surface damage which can subsequently lead to micropitting. Such investigations have concentrated on measuring parameters such as extreme pressure deviations, extreme surface proximities, load cycles experienced by prominent asperities per contact traverse, etc. It has been generally established that 'adverse asperity encounters' can lead to loss of full film lubrication, in the form of local lubricant cavitation and local contact of the surfaces. Both of these effects are considered to be potentially significant in leading to the onset of micropitting and other forms of surface distress.

CAN LUBRICANTS EFFECTIVELY OVERCOME THE PROBLEM?

Both the base fluids and the additives systems have been identified in significantly influencing the onset or prevention of micropitting. When considering the composition of the base fluid, mineral oils are approximately equivalent to polyalphaolefins in terms of their anti-micropitting performance, whereas esters are significantly worse, and polyglycols significantly better. These relative differences in performance are thought to be attributed to the relative frictional coefficients of these base fluids, these being 0.125, 0.120, 0.105 and 0.080 respectively. The viscosity of the lubricant is also significant; the higher film thicknesses associated with higher viscosity lubricants are considered to be beneficial in combating the onset of micropitting.

Additive selection, however, is not as straightforward, since the additive combination must not only protect gear surfaces, in terms of extreme-pressure and micropitting resistance, but also protect against corrosion and rust. Since all such additives operate by modifying the surface characteristics to a greater or lesser extent, there will be competition for surface adhesion by the different types of additives, which can adversely affect the overall performance of the lubricant, particularly in terms of its rust inhibition properties. In addition, many of the conventional sulphur/phosphorus extreme-pressure and anti-wear additives traditionally used to prevent e.g. scuffing, can actually accelerate the onset of fatigue, corrosion and micropitting. Also, the same fluid may well be required to lubricate other items, such as bearings, in addition to gears, so that other properties may need to be taken into consideration. It now appears that, with proper formulation, the lubricant can well offer protection against micropitting. Lubricants containing certain ashless additives, and based on both mineral and synthetic base fluids, have been successfully used in prolonged trials involving wind turbines with a complete absence of micropitting.

HOW IS ANTI-MICROPITTING PERFORMANCE EVALUATED?

Tests to evaluate lubricant performance were developed over ten years ago by the FZG Institute in Munich. However, these tests were too lengthy to be considered suitable for routine use, each test taking a period of weeks to evaluate each sample of candidate oil.

Thiessens, the worlds largest gearbox manufacturer, have since developed simpler and more rapid procedures, which, also using the same principles as the FZG test, uses different gear geometries and metallurgies. A number of other approaches have also now been investigated, all of which employ some form of mechanical simulation. A number of methods, whilst not practicable for routine use, have been useful in pinpointing specific additives which are particularly effective in reducing micropitting.However, it is generally considered that there is still a requirement for simple and rapid test methods, which specifically and reliably measure lubricant micropitting performance.

FUTURE DEVELOPMENTS.

In the UK, the British Gear Association/Gear Research Foundation are actively investigating micropitting, under Project 6. This project in particular is involved in improving the understanding of what causes micropitting, in investigating the use of materials and surface finishes, in validating test procedures against different gear geometries, in the investigation of lubricant chemistries, and in the development of suitable screening test procedures.

The situation can be summarised by stating that, in the current situation, there is a limited but growing understanding of the fundamentals of micropitting. Investigations have in the past been hampered by the lack of well-documented case histories since the role of micropitting in historical catastrophic failure situations had never been properly appreciated.

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