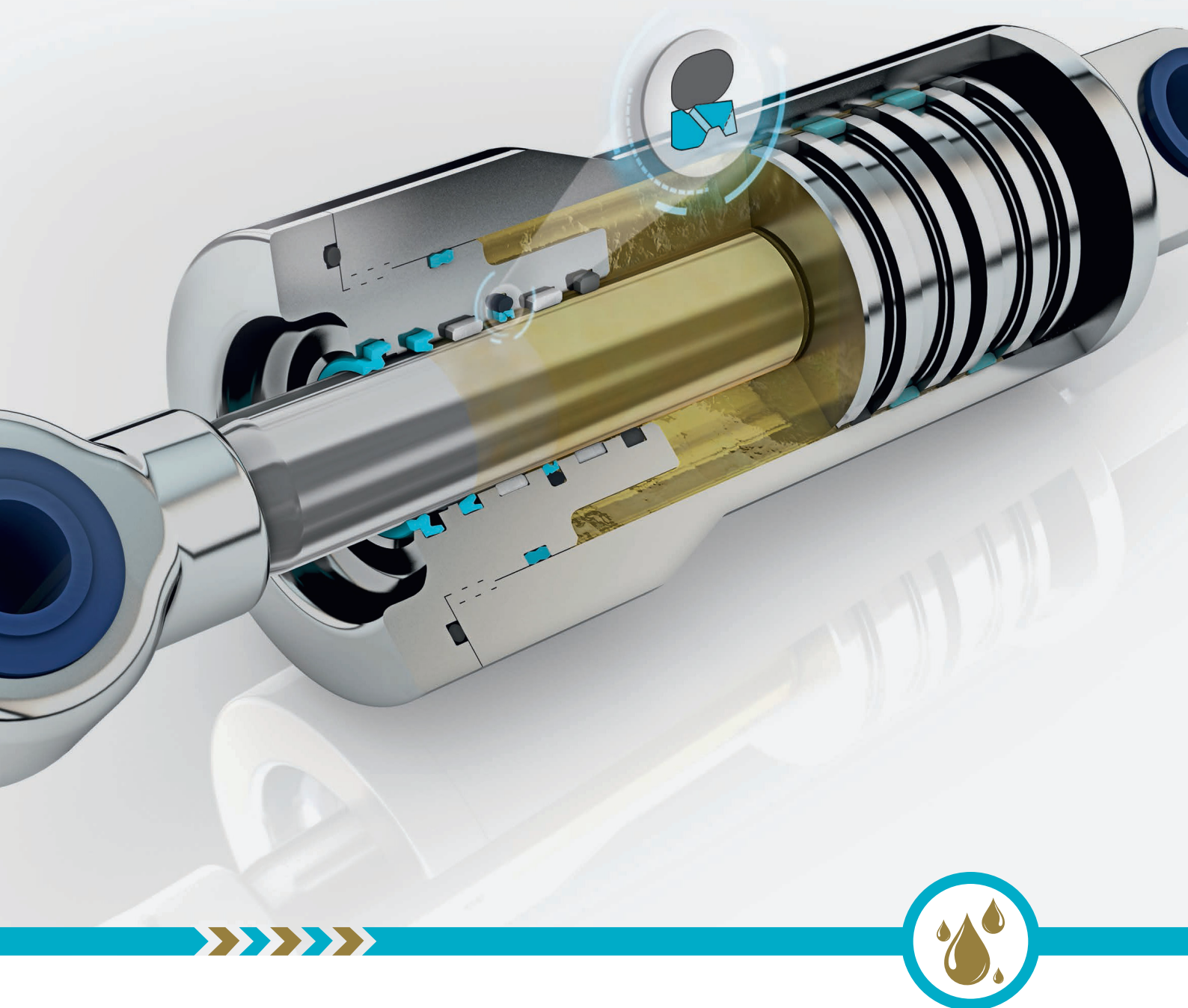


An Introduction to Lubrication Management



Introduction

“When engineering a sealing system, all elements must work together as a team.”
— **Holger Jordan**, Segment Manager Fluid Power Europe, Trelleborg Sealing Solutions

Performance. Efficiency. Longevity. These are the things that matter in engineering. They're also the things that an effective sealing and lubrication system safeguards – and such a system demands a fresh approach to lubrication management. An approach that sees each element not separately, but as a complementary component of a unified whole. A team approach is, essentially, the foundation of good lubrication management – and, in a field that is still very much in its infancy, the long-term benefits are proof of this.

This white paper is not an in-depth encyclopedia of sealing and lubrication management. Rather, it is a primer: a useful overview of lubrication management through the lens of sealing solutions.

It draws on the expertise both within Trelleborg Sealing Solutions and in the wider industry to provide a 'jumping-off point' in tribology. A point at which you can deal in the world of sealing and lubrication with a greater knowledge and grounding – from its history and development to the latest solutions and approaches. Its aim is to provide you with a deeper understanding of how a team approach delivers performance, efficiency, longevity, and a smooth-running operation.



The Story So Far

The Development of Lubrication Management

“In a civilisation that depends on machines, materials that lubricate moving parts are absolutely essential.”

— **Kevin J. Anderson, MRS Bulletin**

From the invention of the wheel, and the discovery that animal fat smeared on the axles would ease movement¹, right through to the cutting-edge machines of today's heavy industry, lubrication has been integral to the story of humanity's innovation and development. The scientific discovery of friction, the rise of petroleum lubricants, and the advent of synthetic solid, semisolid and liquid lubricants are all parts of the story – and lubrication management is the latest step along the way to improving the performance of the machines that make the world turn.

Today, lubrication and sealing are critical areas for the performance of the total machine – and it's widely recognized that a fundamental challenge in sealing moving machine parts is ensuring good sealing qualities and long service life. They're inextricably linked, and crucial to the avoidance of failure. However, they're also often overlooked by plant management, whose maintenance budgets are allocated elsewhere – as figure 1 shows.

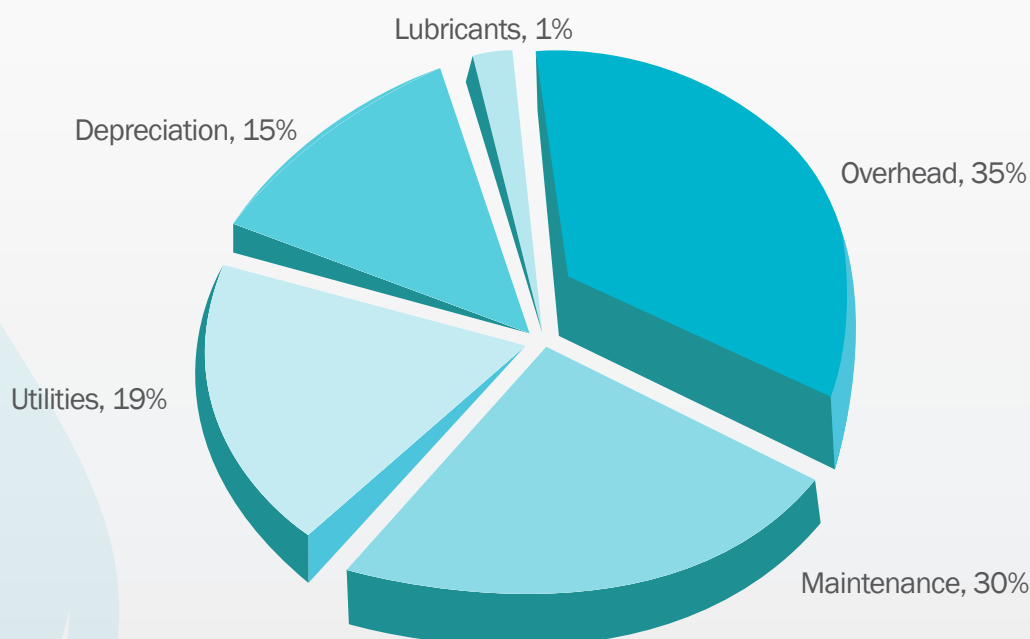


Figure 1: The bottom Line impact of Lubrication²

This chart shows an average breakdown of overall plant operating costs by category.



Despite this low awareness and concern, lack of effective lubrication has been highlighted as the predominant cause of premature machine bearing failure – as figure 2 shows.

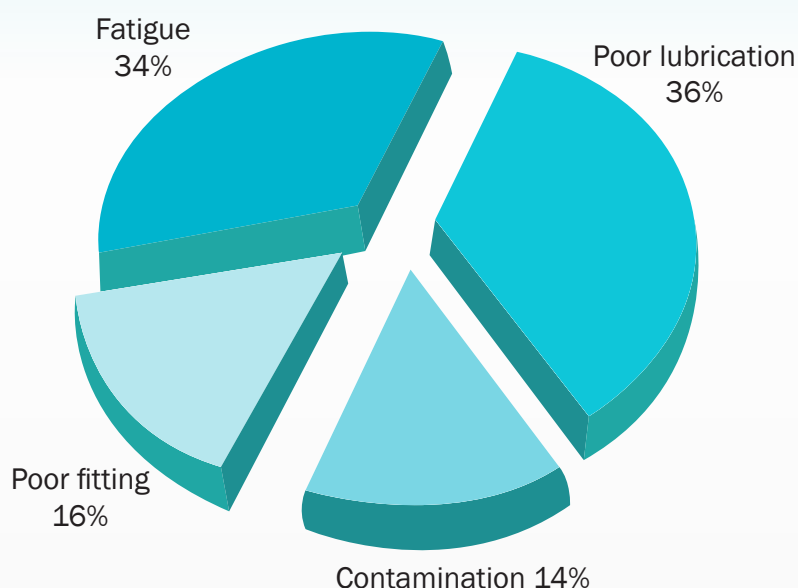


Figure 2 - Premature bearing failure³

Evidently, there's a real discrepancy here between awareness and effect. We'll be looking at the challenges and cost of failure in greater detail shortly but, if anything, this discrepancy highlights the need for more effective lubrication management.

But what exactly is involved? Essentially, it's more than simply choosing and applying a lubricant. It's about managing and adjusting the lubrication conditions of all elements within a sealing system, so the load on each element can be reduced and performance in terms of friction-wear lifetime can be optimized. A more holistic approach to machine maintenance, it's focused on the friction points: the seals and bearings, the interfaces between surfaces in motion that are constantly subjected to pressure and wear.

Crucially, as opposed to a lubricant-focused approach, effective lubrication management "begins with the end in mind"⁴. It's no longer about smearing animal fat onto your wheels just because it's seen to work. Given the complexity of today's industrial machines, a suitable lubrication management program will take a strategic, problem-solving stance. With an aim to reduce unplanned downtime and cost while upholding the integrity of the sealing system, doing this means assessing the problem before devising the right solution through materials, application and maintenance. In keeping with this, we now turn to the challenge that friction presents for industry.



The Challenge

The Ongoing Battle against Friction

We live in a Dynamic universe. Things fall apart. Energy continually shifts from one state to another. Perpetual motion is prevented by friction, wear and resistance at the atomic level. In this physical universe, lubrication is one way of holding back the tide of entropy – making equipment run smoother, perform more efficiently, and last longer. One of the fronts of this battle is a machine's seal contact areas; friction points that mean the difference between costly repairs and smooth running.

The exponential growth of technology and resultant demands of an always-on world mean that today's machinery is increasingly dynamic – more intricate, precision-engineered and efficient. But this doesn't mean it can break the laws of physics. Friction, wear and pressure all pose threats to this machinery, potentially causing part failure, service downtime and, ultimately, cost. And in applications where seals play a critical safety and operational role, from O-Rings to rotary shaft seals, the challenge of friction and wear is multiplied – again, exponentially.

Tapping into Trelleborg's own expertise in hydraulic sealing for fluid power

Friction – like in other applications – is the great enemy. Creating wear on seals, it manifests in a variety of ways – for example:

1. Pressure and speed

As we've established, the demands of society and advances in technology have resulted in smaller, lighter machines. However, adversely, this reduction has led to increases in pressure and speed of hydraulic applications – pushing polyurethane seals to their material limits.

2. Coating of counter surfaces

While maintenance engineers and facility managers are often aware of the need for smoother coatings of interfacing surfaces in hydraulic applications, these are often chosen for technical reasons, without considering the sealing system. As a result, they can severely limit the lifespan of both seals and the wider machine.



3. Rough surfaces

Look closely at any interfacing surface, and you might see tiny imperfections – embedded holes, uneven textures, friction-creating characteristics. In the high-speed applications mentioned above, each of these tiny flaws or patterns acts like a knife; cutting the seal as it passes, and abrading its integrity.

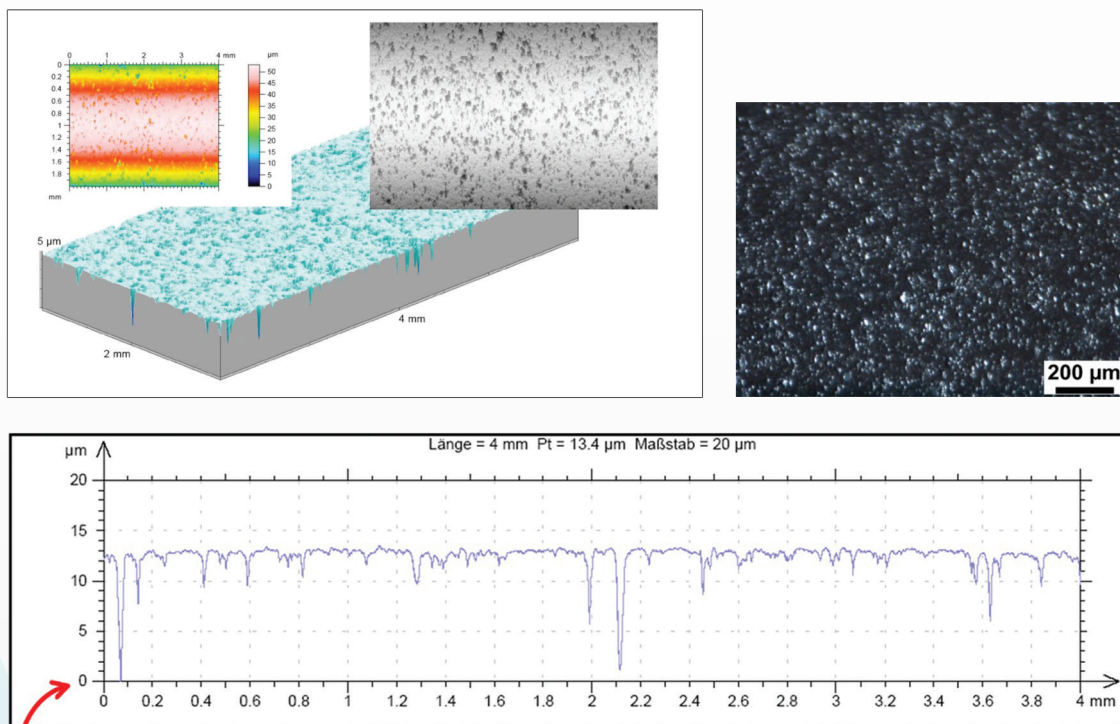


Figure 3 - Roughness in the counter surface is challenging for sealing systems



4. Modifications and post-processing

Coating, processing and modifications that prevent wear are a common solution to enhancing the life of seals and applications. The challenge here, however, is cost. Carrying out these modifications in isolation can carry huge costs, both financially and in terms of downtime that can erode a company's competitive edge, internationally.



Of course, these are very specialist challenges – but we mustn't lose sight of the bigger picture when the cost of failure is downtime.

Lubrication, while often overlooked, is a huge contributor to unplanned and planned downtime whether that's because of excessive wear or temperature increases, or through contamination, leakages, inadequate lubricant application or any number of other small but critical problems. Lubrication management is a major step in minimizing and even eliminating this downtime through proactive planning and maintenance.

The challenge of friction in ensuring seal integrity, quality and thus longer service life is by no means limited to the factors outlined above. However, they do paint a good picture of the issues faced by modern machinery, which leads us to their solution: effective lubrication management.



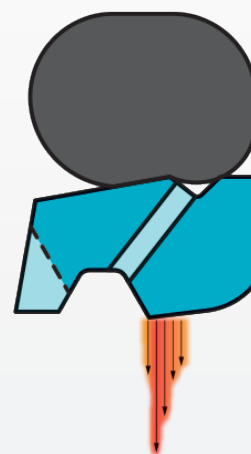
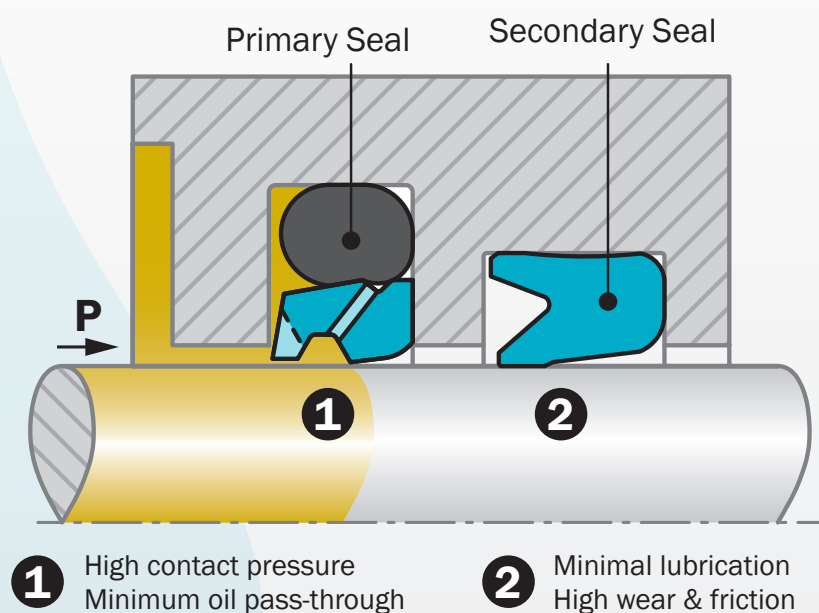
The Solution

The means to enhance performance

As we stated back in the introduction to this paper, when engineering a sealing system to cope with the ever-present challenge of friction and the ever-increasing demands of today's world, all elements must work together as a team.

It goes without saying that applying lubricants to seals under pressure loads can extend the life of the seal and mitigate the effects of friction and wear. But this is a simplistic view, given the aforementioned speed and pressure challenges of modern machinery – as well as the mandatory need for redundancy in critical industrial applications.

In fluid power and hydraulic sealing applications, best practice comes in the form of a primary and secondary seal. The primary seal does the grunt work, maintaining integrity for as long as possible; the secondary seal is the redundancy measure – ready to step in when it's needed. Even here, however, there's a pressing challenge...



Seal edge with standard contact pressure distribution

Figure 4 - Standard Sealing System



Imagine that the primary seal does its job perfectly, for an extended time. No lubricant is getting past it. This creates dry running conditions for the second seal – and, should it need to step in, this will create wear issues. Without proper lubrication management such a situation would be workable.

We've covered what lubrication management is, but what exactly does it do? In essence, it balances the risk of lubricant leakage to ensure

both the performance of the primary seal and the extended life of the secondary seal. This is achieved by allowing a thicker, higher-quality film of oil underneath the pressure-loaded primary sealing element, to reduce the load on that seal. The film volume transferring past the primary seal is then controlled through an integrated check valve to the contact area of the second seal and the counter surface.

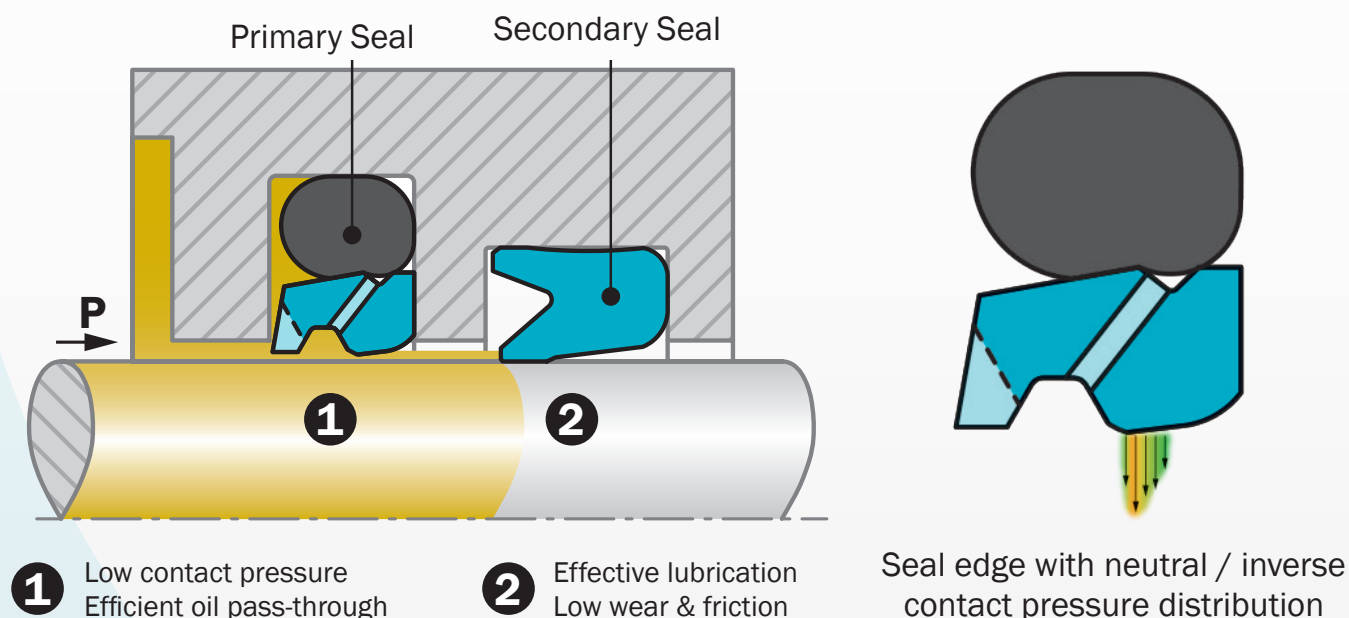


Figure 5 - Lubrication Management Sealing System

The good news is that the recent surge in interest in lubrication management means that a number of sealing profiles can be used for this task, including Turcon® Stepseal® V and the Zurcon® Buffer Seal. So, there is choice and flexibility

in applying a lubrication management system – but the real question now is how lubrication management systems perform in the real world.



Evidence

Putting it into practice

Determining the ideal lubricant management program is a lot like solving a Rubik's Cube."

Matt Mohelnitzky, U.S. Lubricants

Lubrication management – like any industrial process – needs to be tested before becoming proof of concept. Particularly, a system needs to be tested to determine the optimum method of control in terms of wear inhibitors and lubrication type.

For example, running a test using a Zurcon® Buffer Seal saw a significant reduction in interference – with compression set behavior reduced by almost 50%. This reduction was echoed throughout other tests, becoming a common factor, even improving the reduction by up to 70% in certain circumstances.

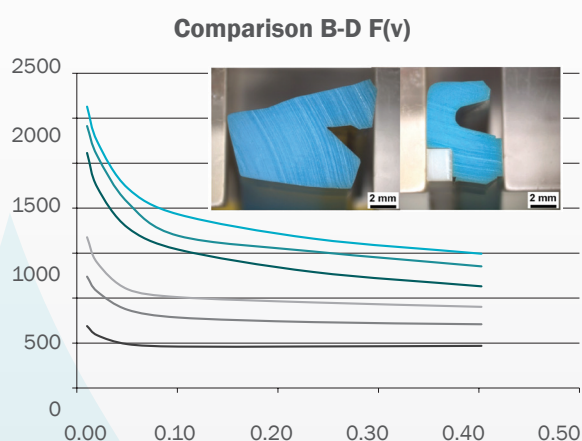


Figure 6 - Friction forces in standard sealing system

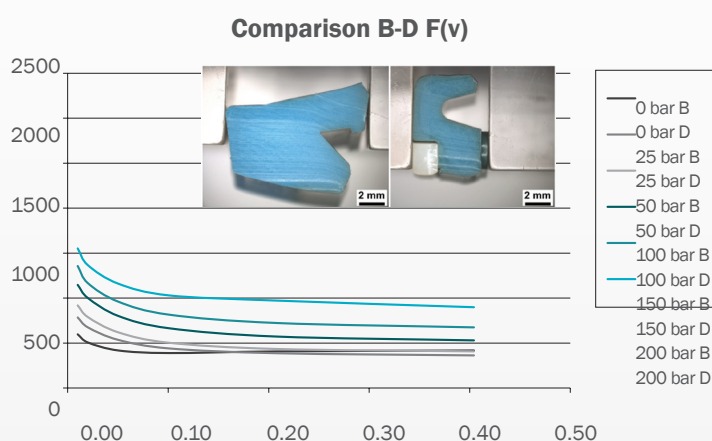


Figure 7 - Friction in Lubrication Management sealing system

Of course, one of the major concerns for lubrication management in practice is the lubricant used in any given application. While industry has increased the use of mineral oil, synthetic lubricants and greases carry a number of real-world benefits, as John Bickley points out:

- Increased wear protection
- Wider temperature range
- Longer oil life
- Improved bottom line⁵



So, while the initial cost of a conventional lubricant may well be lower, effective lubrication management should account for the total, lifetime cost of the system. And with synthetic lubricants providing these benefits, the long-term impact on machine condition, seal performance and wear resistance far outweighs the cost.

As always, lubricant choice should not be a snap first decision; it should always be linked to the application's requirements for viscosity, temperature, speed and pressure load, as well as accounting for the environment in which the

system will be operating. This also goes for other elements – in fact, ensuring the entire proposed sealing system, and all components within, are intelligently designed to suit the application and enhance your equipment. These are complex considerations, often requiring specialist knowledge – which, returning to our theme of thinking of sealing systems as a 'team'; it requires teamwork.



Partnerships

Gather your team

“A little basic lubrication training can significantly boost understanding and enhance your program.”

Ken Bannister, Maintenance Technology

This paper is an introduction to the field of lubrication management – with a host of theoretical formulae, testing data and performance metrics underpinning it. In fact, the subject matter is so complex, it's easy to become lost. That's why our last piece of advice is this: get advice.

From an application and environment-driven choice of lubricants to control mechanisms and maintenance planning, lubrication management features a wealth of concerns and considerations. It's an intensely specialist arena, and it can take years to accrue the expertise to make the best decisions and eliminate errors. So, it's important to work with a partner with the requisite knowledge and skills to devise and implement your program. Even beyond this, a lubrication management

partner can act as an adjunct to your team, imbuing the same skills and knowledge in your personnel over time, through training, education and daily collaboration.

Ultimately, by leaving lubrication management in the hands of an experienced, objective partner, you can gain the benefits of such a program, including increased performance, reliability and equipment life, without it becoming a dominant concern of your day-to-day work. In summary, let your partner handle tribology while you focus on the bigger picture. It's the ultimate realization of the team approach that we advocate for your sealing system.



Summary

In Closing

“No single focus will have a higher impact on machine reliability than a fully optimized, fully documented and properly implemented precision lubrication program.”

Matt Spurlock, STLE

Performance. Efficiency. Longevity. We began this paper talking about what matters to industry. And, as Deepak Katnala, of the Society of Tribologists and Lubrication Engineers, pointed out in 2011, “Looking back 10 years, lubricants were never considered important.” This is all set to change.

The demands of the modern world are placing increased pressure on your machinery to work reliably for longer, while ongoing economic pressures are fueling a never-ending quest for cost-effectiveness. Against this rocky backdrop, it's essential to keep things running smoothly – and a lubrication management program does this.

This has been but a brief introduction to the discipline; a quick overview of some of the key challenges you'll face, the solutions that can

overcome them, and some tips for putting it into practice in the real world. Where you go from here is up to you. There's plenty more material out there with oceans of data and empirical recommendations to wade through – just as there are partners ready to help you make sense of lubrication management. The one thing that's certain: as technology marches onward, lubrication in your equipment's sealing systems can no longer be ignored or downplayed. Only by having your system, and your people, working as a team will smooth running be assured.



References

- 1 Anderson, K.J., 'A History of Lubricants', <https://www.cambridge.org/core/services/aop-cambridge-core/content/view/S0883769400055895> (retrieved November 2016).
- 2 Bickley, J., 'Proper Lubrication Practices Improve Plant Operations', <http://www.powermag.com/proper-lubrication-practices-improve-plant-operations/?pagenum=3> (retrieved November 2016).
- 3 Richards, B.G. & Michalicka, P., 'Developing An Effective Lubrication Management Program', <http://www.maintenancetechnology.com/2013/08/developing-an-effective-lubrication-management-program/> (retrieved November 2016).
- 4 Bickley, J., 'Proper Lubrication Practices Improve Plant Operations', <http://www.powermag.com/proper-lubrication-practices-improve-plant-operations/?pagenum=3> (retrieved November 2016).
- 5 Bickley, J., 'Proper Lubrication Practices Improve Plant Operations', <http://www.powermag.com/proper-lubrication-practices-improve-plant-operations/?pagenum=3> (retrieved November 2016).
- 6 Johnson, Metal, 'Lubrication technology and management: The next 10 years', http://www.amm.com/pdf/Best_Practice_38Lubrication_MngtThe_Next_10_Yrs.pdf (retrieved November 2016)





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Holger Jordan has been working for Trelleborg Sealing Solutions since 1990. As Segment Manager Fluid Power Europe he is responsible for this business area, coordinating development partnerships in a close cooperation between our customers, TSS competence centers and production sites.



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