

Trelleborg Sealing Solutions

# *in the* **groove**

*The world of seals and service*

Materials

## Turcon® M12 – A universal answer

New high-performance material  
works in virtually every sealing  
application

Turcon®  
**M12**



Products

### Flatly effective

Best-in-class gaskets for challenging environments



Service

### Why sit still when you can work on the go?

Innovative iPhone app, "ISO Fits and Tolerances"

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### Why sit still when you can work on the go?

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## Products

### Flatly effective

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#### Service

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Learn more about the latest versions of Trelleborg's online tools.



Food and pharmaceutical



# Maintaining compliance

The Turcon® MF range of Polytetrafluoroethylene (PTFE) based sealing materials has been specifically formulated for food contact, pharmaceutical and medical applications. The range of materials must therefore comply with the EU's plastics directive 2002/72/EC (former 90/128/EEC.) Third party tests have confirmed that all Turcon® MF materials continue to comply with various amendments and additions recently made by the European Communities Commission to the directive as stated in Article 5 of the Regulation (EC) 1935/2004.

### Still compliant

“Formulations have been re-checked against all amendments,” says Ferdinand Schwabe, Food, Beverage

and Pharmaceutical Segment Manager for Europe. “Test specimens were submitted to a renowned external test house for migration testing and sensory testing. They were exposed to food simulants for aqueous, acidic, alcoholic and fatty food. Based on positive test results new certificates were issued, meaning we can continue to provide outstanding sealing materials for hygienic applications.

“In addition, as stated in Regulation (EC) 2023/2006, there is a requirement to follow Good Manufacturing Practice (GMP) with stricter documentation duties and special handling of food contact materials. Special handling for Turcon® MF has therefore been introduced into the Trelleborg Sealing Solutions molding department.”

Films



# Clean sealing on film

Trelleborg Sealing Solutions now has a large number of movies about our products and industry solutions for you to watch. Recently added is one on recommended seals and materials for the food, beverage and pharmaceutical industries. From it you can get a taste of our range of products specifically developed for one of the most challenging sealing environments.



Logistics



# Logistical Expansion: Americas

This fall, Trelleborg Sealing Solutions expanded its logistics presence in the Americas. To accommodate growing customer demand, Supply Chain Management (SCM) Americas moved its headquarters to a larger, upgraded location with 929 sq m/ 10,000 sq ft of office space and 8,360 sq m/ 90,000 sq ft of warehouse space. Still located in Fort Wayne, Indiana, the facility is strategically placed to provide outstanding service and support to customers throughout North and Latin America.

“Fort Wayne plays a significant role in the operations of Trelleborg Sealing Solutions globally,” says Kevin Fosnaugh, Director SCM Americas. “Growing here is a sign of strength for the organization as a whole; not only is Trelleborg growing in Europe and Asia, but in the Americas as well. This expansion will allow us to add more value-added services like special packaging and kitting for our customers which enhances our manufacturing capabilities.”

“The new location provides a collaborative work environment,” says Dr. Thomas Uhlig, President, Global SCM. “Key departments will be located together in the expanded office space, and the larger warehouse gives Americas SCM the opportunity to keep pace with continued growth.”



Social media



## Getting social

The Internet has undoubtedly transformed the way we do business. Now, a new age has dawned with online social networking, as people connect virtually through Facebook and Twitter. Some 500 million Facebook accounts already exist, and there are expected to be 610 million by 2011. An incredible 175 million are logging in everyday.

This is revolutionizing how we make and manage our relationships. At first these networks were thought only to

be for the younger generation and personal interactions. Now though, all ages are involved, and there is a shift to social media as a platform for making business connections.

Keep updated – join Trelleborg Sealing Solutions at:

On the web



## Industry news for you

Looking for news related to your industry – then look no further!

Trelleborg Sealing Solutions is hosting a couple of news portals. For those of you in the windpower or hydropower industries, we can provide you with the latest news as it happens from all around the world.

Why not check it out:

Catalogs



## New hydraulics catalog

Trelleborg Sealing Solutions make available online some of the most informative product catalogs and tools. But we do recognize that engineers also like their catalogs in print. This is why we are continually updating and expanding our range of printed catalogs. The latest one to have a complete overhaul is the metric version of the Hydraulic Seals-Linear.

The fully revised catalog is over 600 pages long and incorporates information on existing and newly introduced seals for hydraulics applications. These include our market-leading range of proprietary rod and piston seals along with scrapers and Slydring®.

You can order the print version from your local Trelleborg Sealing Solutions marketing company or, if you are happy with a pdf, that can be downloaded from our website.



New version available in February 2011

## All-In-One

Fed up of searching for the Trelleborg Sealing Solutions catalog you require? Can't find it on your well-thumbed book shelves or is it lost somewhere in your computer filing system? Well search no more, we have the solution.

Contact your local Trelleborg Sealing Solutions marketing company and they can supply you with our All-In-One Literature DVD. Easy to use, it contains all of our industry-leading catalogs.



**Trelleborg Sealing Solutions**

In the groove, No. 2, 2010

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# Moving mountains

At any one point in time, there are over 100,000 Liebherr earthmoving machines in operation worldwide. When one of these breaks down, Liebherr and Trelleborg Sealing Solutions work hard to supply original spare parts around the clock to keep downtime to an absolute minimum.



## In short...

- The Liebherr Group has supplied 100,000 earthmoving machines currently operating worldwide.
- Earthmoving equipment contains hydraulic systems, which include pistons.
- Under the difficult operating conditions faced by these machines, the piston seals will eventually fail.
- Trelleborg Sealing Solutions supplies the Liebherr warehouse with customized replacement seal kits, ready for dispatching to construction sites around the globe.

For the earthmoving machinery sector, Liebherr produces an extensive range of hydraulic excavators, hydraulic rope excavators, crawler tractors and loaders, wheel loaders and dump trucks. Liebherr ensures its products meet the high demands of the industry by in-house production of major sub-assemblies, including hydraulic systems. The pistons in these systems incorporate seals, scrapers and wear rings manufactured by Trelleborg Sealing Solutions.

“When one of the pistons fails, as it inevitably will under the tough conditions of a construction site, Liebherr does everything in its power to get the machine working again as soon as humanly possible,” explains Hugo Konrad, who heads a team of six responsible for procuring the spare parts for earthmoving machinery at Liebherr’s central warehouse in Kirchdorf, Germany. “The replacement parts are normally on the plane the same day,” he adds. In total, the plant houses some 80,000 original parts for all Liebherr’s various products in use around the globe.

## Unique cooperation

Among these are replacement seal kits supplied, in advance, by Trelleborg Sealing Solutions. As part of a unique collaboration

# to keep earthmovers working



between the two companies, Trelleborg Sealing Solutions puts together these customized kits, which contain between five and 15 components, depending on the piston in question. These are boxed in the familiar yellow cartons supplied by Liebherr, together with a packing list, and then sealed with a security label. Around 23,000 of these kits are delivered to the Kirchdorf warehouse each year, ready for dispatch anywhere in the world.

“We don’t need to check the contents,” comments Hugo Konrad, “Trelleborg ensures the packing is correct, plus we’ve always been very satisfied with the high quality of the individual components.” At least 95 percent of the contents are made by Trelleborg Sealing Solutions, the rest being grease and lubricants that are ordered from Liebherr’s own suppliers. This collaboration has been running for over 20 years now, and Hugo Konrad points out that his department receives very few customer complaints.

## Immediate response

“Even if we know we could source the components on the open market,” continues Konrad, “we want the best possible quality for our own clients. That’s how we keep our customers

satisfied.” He is quick to praise the communication between the two companies, although he has to admit that things run so smoothly that for years he had no reason to contact Trelleborg Sealing Solutions. “But when I do have to phone my contact at Trelleborg, they go into action immediately.”

This was the case earlier this year when Liebherr called upon Trelleborg Sealing Solutions to step up deliveries of its various seals in line with the upturn in the Liebherr’s earthmoving and mining divisions. Turnover from these two business units rose by 110.8 million EUR to 951.8 million EUR in the first half of 2010, representing an increase of 13.2 percent.

The Liebherr Group anticipates this significant growth in sales revenue to continue through the months to come. And Trelleborg Sealing Solutions will be playing its role in this special partnership to ensure Liebherr is able to meet its customers’ demands.

# Hygienically sealed

EHEDG develops and harmonizes standards for food equipment design around Europe. Our expert in this field, Ferdinand Schwabe, talks to Knuth Lorenzen, the President of EHEDG, about its origins, ongoing work and how relevant this is to the world of elastomeric seals.



## In short...

- In advance of new EU guidelines for elastomeric seals, the president of EHEDG speaks exclusively with Trelleborg
- There is a need to define, develop and harmonize international food hygiene standards
- Hygienic design is often disregarded, meaning education is required to ensure improved levels of food safety

## Consumer health must be safeguarded

There are inherent requirements to safeguard the health of the consumer. For example, microbial contamination must be controlled at source, as the time taken to transport food can encourage spoilage growth despite speed and good storage. Otherwise, contamination during processing could spread health problems internationally, due to the wide distribution of food.

Of course, we have laws and guidelines to promote hygiene and good health, which have evolved over many years. However, these are complex and may be difficult to implement in terms of equipment design.

## Harmonizing standards

To help food manufacturers and processors in the EU and across the world achieve hygienic equipment design, the European Hygienic Engineering and Design Group (EHEDG) was founded to help harmonize standards across Europe and also assure adherence to major international hygiene standards around the world, particularly in the USA. This reflects the global production of food, as producers who export to these countries must also conform.





Krones AG



Ferdinand Schwabe, Food, Beverage and Pharmaceutical Segment Manager for Europe, is a member of EHEDG. Working on sealing guidelines, he is the Trelleborg Sealing Solutions contact for 3-A, a similar organization in the U.S.

Knuth Lorenzen, President of the European Hygienic Engineering and Design Group (EHEDG)



# The big interview

**FS:** Why was EHEDG first started, what was the need for it?

**KL:** We had too many food-borne diseases as a result of non-hygienically designed food processing equipment, process lines or plants. For example, in 1990 there were 10 million cases in Europe. The economic side effects include loss of product due to spoilage or quality defects, high cleaning costs and low production time, as well as sickness in workers.

For this reason, in 1989, the European Union (EU) came up with directives for food processors and food machinery manufacturers, like Directive 178/2002/EC for Food Hygiene and Directive 2006/42/EC for Hygienic Design of Machinery. But these have hundreds of pages to read and, for those unfamiliar with the industry, are not easy to understand.

So, in 1989, EHEDG was established to try to help people deal with the directives and train and educate people from the industry in hygienic design. We develop easy-to-understand materials like guidelines, training materials and test methods with lots of illustrations. These were supplemented by animations, films and practical hands-on seminars, lectures and workshops to help the industry learn from best practices.

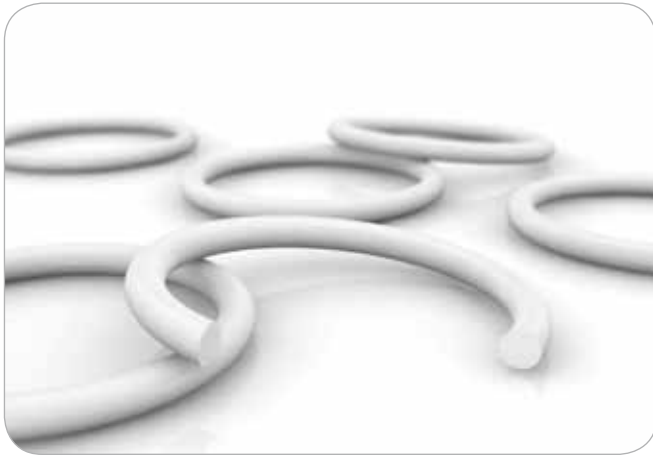
**FS:** What is EHEDG's relationship with other major hygiene standards bodies, e.g. the FDA in the USA, the ISO/EN and the DIN / BS boards?

**KL:** EHEDG guidelines set the base for the national and international standards and EHEDG educates people to understand and deal with hygienic design. We work closely and cooperatively with U.S. bodies such as NSF, the FDA and 3-A.

**FS:** Why are seal design and materials so important to hygiene?

**KL:** According to the Machine Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006: 2.1.1. General (b) all surfaces in contact with foodstuffs or cosmetics or pharmaceutical products, other than surfaces of disposable parts, must be smooth and have neither ridges nor crevices which could harbor organic materials. The same applies to the joints and the seals within them.

We are at present writing an EHEDG guideline specifically for seals. This will increase the awareness of all aspects of hygienic equipment design for effective sealing and seal installation. This will be aimed at the processors, manufacturers, distributors



It is important that seals, such as these O-Rings, are smooth and have neither ridges nor crevices which could harbor organic materials.



Trelleborg Sealing Solutions offers gaskets and O-Rings for the most common standards that apply to hygienic-design couplings in materials specifically engineered for hygienic-design coupling applications.

and agents, including certification of seals and the specific equipment with which they are designed to be used.

**FS: How is EHEDG working within today's regulatory developments in the EU?**

**KL:** EHEDG aims to strengthen the cooperation with the EU to influence the regulatory groups with scientific and technical guidelines on all aspects of state-of-the-art hygienic design requirements.

**FS: How do you see EHEDG developing?**

**KL:** Though we have been operating for 20 years, we still find ourselves confronted daily with deficiencies in hygiene which compromise food safety. These may be flaws in the storage chain, in households, faulty distribution or in the catering chain. We also discover hygiene failings in the production process itself and the actual operation of facilities and plants.

Hygienic design very often gets disregarded when production facilities or parts of them are planned, produced or assembled. Even in the areas of development and design for the food industry, we find engineers who, in their university studies, never had the opportunity to acquire the necessary hygiene-related skills. It is, therefore, hardly remarkable that we are confronted with hygiene deficiencies every day. The flaws originate in the lack of education in food hygiene and hygienic design.

*"Hygienic design very often gets disregarded"*

It is here that we wish to help. We offer our wide ranging knowledge - which has been collated and created by experts from the global hygiene network - to industry, trade, schools, universities and institutes.

Our expertise is comprised of hygiene-related literature, training courses, workshops, symposia and seminars. Its

target is to close the existing gaps in knowledge and training where food hygiene and hygienic design is concerned.

*"..spread the knowledge about food hygiene and hygienic design worldwide"*

In doing this, we do not wish to limit ourselves to only a small geographic region of the world. We have, therefore, started to establish regional sections worldwide, which will disseminate our expertise and our ideas and concepts in various languages.

This is the only way to guarantee that over the course of time we shall be able to broaden and spread the knowledge about food hygiene and hygienic design worldwide so that we can enjoy safe food each and every day – and everywhere.

**The EHEDG elastomeric seals guidelines are expected to be published in 2011.**

**Elastomeric seals**

Elastomeric seals are found throughout food, beverage and pharmaceutical processing to prevent material escaping from joints in the equipment, and to stop external agents – liquids, solids, foreign organisms and gases – from entering and contaminating the process.

Fast fact



**Turcon® Variseal® Ultra-Clean™ is Trelleborg's latest ultra-hygienic seal using the unique Turcon® MF PTFE based material to fully enclose a resilient spring. The Turcon® Variseal® Ultra-Clean™ is characterized by low porosity, minimal contamination, high pressure compatibility, excellent chemical resistance and low friction.**

## The U.S. perspective

In the United States, food, beverage and pharmaceutical devices, systems and processors must utilize materials compliant with various industry-recognized certifications. At the very least, each must comply with recognized ingredients outlined in the Food and Drug Administration's (FDA) Code of Federal Regulation (CFR) Title 21 Part 177 "Indirect Food Additives: Polymers."

From this basic compliance, a number of more specific and far more stringent certifications are recognized for each application and intended use. These include 3-A for Dairy and Food Contact Equipment, NSF-51 for materials in contact with consumable foods, NSF-61 for components within systems intended for drinking water and USP Class VI for plastic and elastomeric materials in drug processing equipment. Consideration in ingredients, toxicology, construction and cleanability, as well as many other aspects, are evaluated for material compliance.

Background info

## Meeting unique hygiene challenges

Trelleborg's elastomeric products are found in virtually all hygienic manufacturing processes for food and beverages. A typical processing line requires thousands of seals for its equipment, and it is vital that there is no risk of these seals contaminating the products. As a feature of today's manufacturing, seals have to be compatible with the often aggressive process media and the stringent cleaning regimes requiring destructive chemicals and elevated temperatures, as well as the food or beverage actually being processed.

### Some of Trelleborg's important hygienic seal solutions:

#### Seals for filling heads:

Ultra clean seals prevent leakage and ensure there is no contamination at the critical filling stage of production.

**Products:** Turcon® Variseal® Ultra-Clean™, O-Rings

#### Seals for filling mechanism valves:

Valves control the amount of liquid fed into the bottle. Low-friction seals that withstand aggressive cleaning regimes are required in these dynamic applications.

**Products:** scrapers, molded components, Glyd Ring®, custom-made seals

#### Seals for bottle lifters:

Seals and bearings are required for the pneumatic pistons within the cylinders that lift the bottles for filling. The low-friction and wear resistance of seals are important to maximize productivity.

**Products:** Slydring®, Glyd Ring®

#### Seals for hygienic design couplings:

Hygienic design couplings are located at virtually every connection in the system. Gaskets and seals must withstand stringent cleaning-in-place (CIP) regimes to ensure long life and no contamination.

**Products:** sanitary gaskets, clamp seals, O-Rings

#### Seals for rotary distributors and bearings:

The rotary mechanism distributes the media being processed around the processing system. Special dynamic seals keep grease, cleaning fluids and water out of rotary bearings.

**Products:** Turcon® Roto Variseal®, Turcon® Varilip® PDR, X-Ring, radial oil seal.

**Trelleborg Group also supplies a wide range of other hygienic polymer-based products, including hoses and vibration isolation solutions for processing equipment.**

# An irresistible

Ford needed a drive-axle seal that provided better protection against contamination and wanted something first class for superior quality. So they turned to another company with an ongoing quest for superior quality. They came to Trelleborg Sealing Solutions with the challenge to develop a seal that would far exceed the application parameters of any standard seal on the market.

The result of the challenge was the AG Seal, which integrates the strong points of proven existing Trelleborg Sealing Solutions technologies and rolls them into a single, superior, cost-effective design that radically reduces contamination leakage. A significant improvement in the life of the seal means a significantly longer life for critical drive-train components and solidifies Ford's commitment to produce a quality product.

## Ford was pleased with the results, say Trelleborg engineers.

"Ford and Trelleborg made sure that all validation testing was complete before releasing it into production to ensure Ford was getting a top-quality product," says Michael Smith, Application Engineer for Trelleborg Sealing Solutions.

"After the axle went through Ford's extremely rigorous testing at their proving grounds, it was torn down for inspection. When the axle shaft was pulled from the axle assembly, there was zero contamination past the seal. No dirt, no water, no moisture, no rust!" says Smith. "Ford released the AG seal into production immediately after the axle tear-down, knowing that it will dramatically improve the quality of their axle. This investment in the Trelleborg Sealing Solutions AG Seal is proof that Ford continues to be committed to providing a quality product."

## Broad implications for numerous industries

This new exclusion technology from Trelleborg Sealing Solutions has broad implications for the automotive, agricultural, mining and heavy truck markets and can be used in any application where exclusion and protection from contamination is a priority.



# challenge

The AG Seal can compensate for variances in shaft diameter and poor shaft surface finishes. That means lower costs in shaft material and surface finish processing. Also, a low shaft installation force means no special tools are required for assembly – the seal can be installed by hand. This minimizes installation quality and warranty issues. It's an aftermarket-ready seal.

"The AG seal is a cassetted or unitized seal design," continues Smith. "This provides two significant areas in which we can offer savings to our customers in regards to shaft hardness and surface finish. Since the seal is press-fit to the shaft, shaft hardness is not a priority for the function of the seal. Machining processes that control shaft surface finishes can also be relaxed because the dynamic sealing surface is controlled by the seal manufacturer.

"As well as significant savings in material hardening and machine processing, this seal will reduce potential warranty costs. The AG Seal also comes from the manufacturer pre-greased. This pre-lubrication significantly improves seal life; it's a service- and maintenance-free part."

## 600 percent improvement

This patent-pending seal design accommodates a great deal of eccentricity. The integrated rolling diaphragm technology allows the seal to compensate for significant amounts of run-out, shaft-to-bore-misalignment and axial movement/end-play while maintaining a positive seal. This specific design still seals even when subjected to parameters of 3.40mm /0.13in of total dynamic run-out as well as up to 6.0mm / 0.24in of end-play.

Most significantly, the AG Seal exhibits a 600 percent improvement in exclusion capability over the previous rolling diaphragm seal design that was being used in production. Trelleborg Sealing Solutions conducted over three years of durability testing in the lab and on durability vehicles.

## Testing proved the seals capabilities

In addition to slurry and contamination testing, Trelleborg Sealing Solutions put the AG Seal to the test in a variety of ways, including an assembly force test, shaft insertion force test, force removal test from

housing, cold start-up test, torque-to-rotate test and a high-speed test.

Production of the AG Seal began in July 2009. The seal is currently being used on the Ford F250-F550 front axle, which also employs the Trelleborg Sealing Solutions Trunnion Seal. Together these seals have significantly extended the life of the Ford front axle on the F250 through F550 series pickup trucks.

The AG Seal is a solution to exclude contamination, preventing the ingress of dirt, water, slurry, road spray etc from entering into the axle tube. With the AG Seal keeping the axle tube clean and free of contamination, it allows for the Trunnion seal to function properly and provide a superior oil seal, drastically increasing the life and longevity of Ford's front axle.

## Works in a variety of heavy truck applications

This on- and off-highway axle seal can provide the same performance across a variety of heavy-duty truck applications. "With such an exponentially improved performance over the previous solution, the AG Seal could be a real game-changer," says Quinn Collett, Trelleborg Sealing Solutions Americas Heavy Truck Segment Manager. "It offers a potentially much longer life, which is critical as automotive OEMs continue to stretch their warranty requirements and offer more to customers.

"For Trelleborg," Collett says, "it continues to establish our ability to seal the most demanding applications." Just challenge us and see.

## AG Seal

### Elastomer

High abrasion resistance Nitrile Butadiene Rubber (NBR). Offers durability and cost-effective sealing.

### Metal stampings

1008-1010 CR Steel with zinc plating. (Surface can be nitrided to increase hardness or improve wear.)

### Assembly

Metal-to-metal press fit into Yoke ID. (Manually assembled seal.)

## AG Seal: Features and benefits

Outer static seal ensures easy installation and excellent retention in the bore

Metal-to-metal positive stop controls gland width

Rolling diaphragm endures axle plunge/endplay and radial run-out

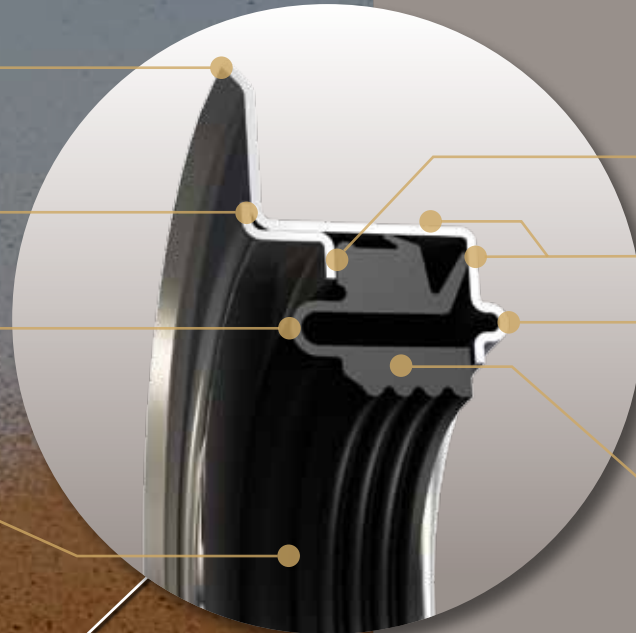
Elastomer has excellent abrasion resistance

Reduced friction, thanks to grease beads applied on rubber-to-metal contact points

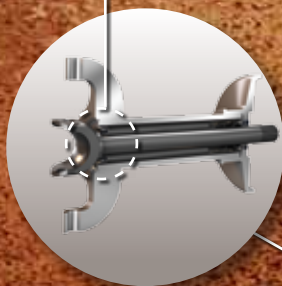
Radial and axial excluder lips defend against slurry

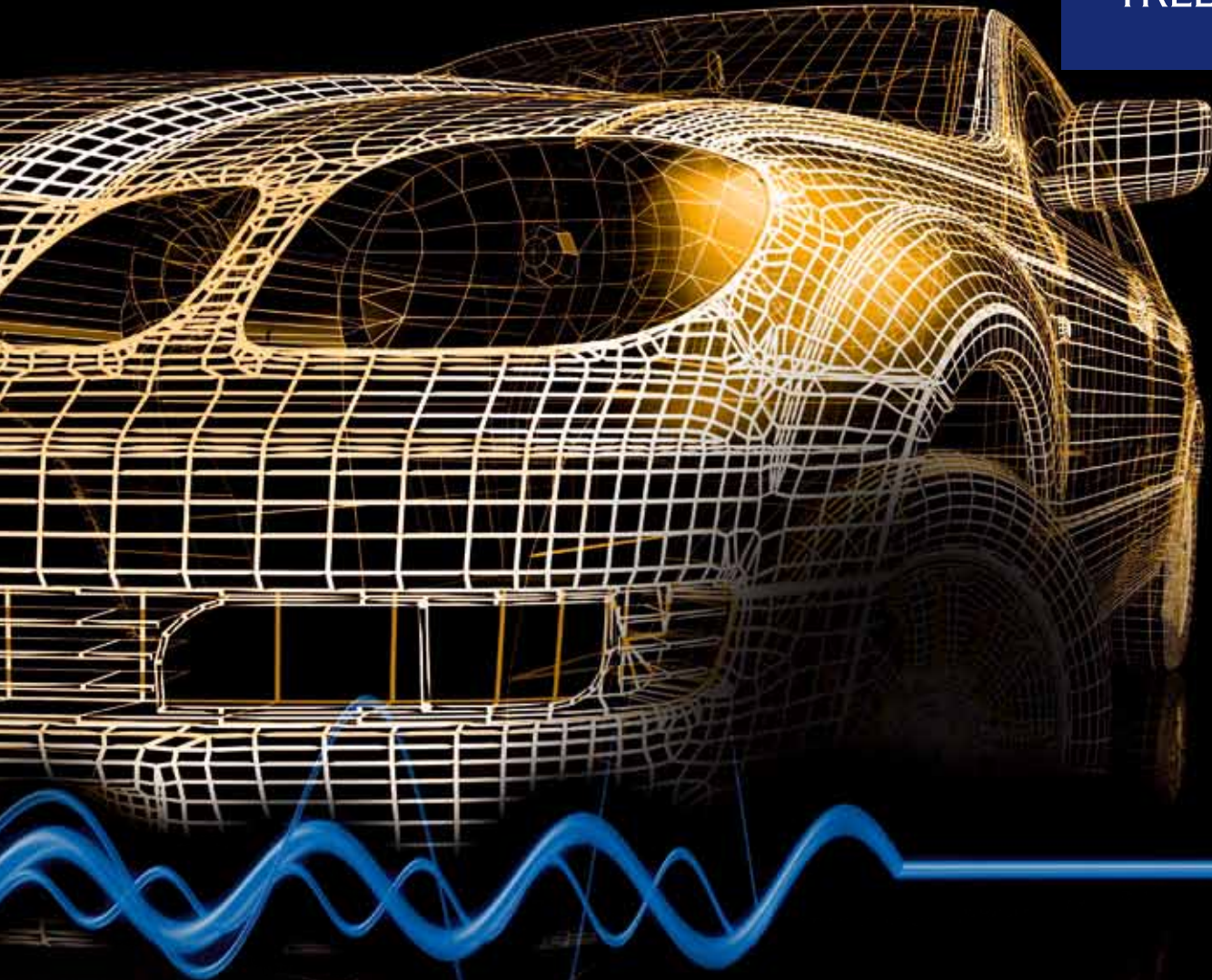
Stress-relief feature on the counter-face metal ensures good lip contact

Beading on the ID of the rubber component allows easy press-fit into the shaft



The patent-pending seal design integrates rolling diaphragm technology. This allows the seal to compensate for significant amounts of run-out, shaft-to-bore-misalignment and axial movement while maintaining a positive seal.





# Some call it acoustic perfection. **We call it Trelleborg.**

► **Sounds of silence.** Energy efficiency is a growing issue for vehicle manufacturers worldwide. However, maximizing combustion efficiency and lowering carbon emissions means new noise problems. Trelleborg's patented damping material enables the next generation engines to be cleaner and run more smoothly and quietly.

Trelleborg is a global engineering group creating high-performance solutions that **seal, damp** and **protect** in demanding industrial environments, all over the world. Find out more about our world at [www.trelleborg.com](http://www.trelleborg.com).



# A brief history of the

by David Shaw, Editor, *European Rubber Journal*

Around 1900, the pinnacle of the steam age was the triple expansion steam engine.

Two of these monsters powered the doomed liner called the Titanic. For a seal designer, the interesting thing here is that the sliding piston seals never had to deal with more than about 5 bar/ 0.5 MPa/ 72 psi of pressure, even on an engine producing 16,000 horsepower/ 12,000 kW.

Part of the reason is that the seals available at the time could not stand much pressure without the risk of failure.

And that has been the history of the reciprocating seal.



The original Newton Abbot Station, Devonshire, England, where Brunel's Atmospheric Railway started. Source: STEAM Museum of the GWR [www.steampicturelibrary.com](http://www.steampicturelibrary.com)

## Rubber and leather

In the 1840s, Charles Goodyear patented the use of sulfur to cure rubber. By 1858, rubber was being used as a static seal in food jars, but dynamic seals still tended to be made from leather soaked in oil.

That approach was also used on Brunel's famous atmospheric railway of 1845, which drew upon the idea of a large steam cylinder. A long pipe, about 380 mm/ 15 inches in diameter, with a sealed slot in the side ran between the main tracks. The locomotive had a paddle, which projected through the slot and acted like a piston within a cylinder.

The pipe in front of the loco was evacuated and the pressure drove the locomotive forward. Initial runs on a short test track were positive, but once more, seal design was the problem.

Not only did the leather react badly to rust on the pipe, but it was lubricated by animal fat, and this attracted rats, whose sharp teeth finished the whole concept of a vacuum-powered railway.

Eventually, in 1887, rubber seals were first used on piston rods in steam engines. Nevertheless, leather remained the material of choice until well into the 20th century.

In 1902, the first machine to liquify air was built by Georges Claude, a French engineer. He successfully used a reciprocating expansion machine in which the piston seal was made from degreased, burnt leather packing, without any lubrication. He built the pressure up to 40 bar/ 4 MPa/ 580 psi, let it cool and then expanded it with almost no loss of energy, resulting in the lowest temperature ever recorded.



The port side engine of the Titanic under construction in Belfast, Northern Ireland. Source: Trustees of National Museums Northern Ireland



# seal



## Rotation and the O-Ring

By the late 1920s, however, rubber seals were starting to enter common service and synthetic rubber seals for rotating shafts were introduced.

Meanwhile, in Europe the adoption of rubber for seals lagged behind America, but its use became more widely accepted with the introduction of a sealing lip for seal rings.

Astonishingly, however, it was not until 1937 that the humble O-Ring seal was devised in the US as an accurately molded ring-shaped piece of rubber located in a groove of precise dimensions. This made a reliable, tight seal against a piston sliding in a cylinder and was patented in 1939.

Even then, however, the O-Ring did not become a commercial success until accelerating mechanical developments during the war took advantage of it.

## Rapid expansion continues to this day

O-Rings were just the beginning; in the years immediately following their invention, a whole range of seals were invented, many for specific purposes, using specific elastomer materials.

Since then, we have developed all kinds of different designs for dynamic reciprocating seals, and invented many different materials, but it all goes back to those initial ideas.

## The PTFE Revolution

About the same time as the O-Ring was first on the drawing board, in 1938, Dr. Roy Plunkett of DuPont discovered PTFE (polytetrafluoroethylene) during tests with fluorinated cooling agents. The new product was resistant to all types of solvents, had a very low friction coefficient and a very wide temperature range from cryogenic to +270°C/ +518°F.

In the early 1950s, interest increased in this new material for seal applications and, in California, Bill Shamban set up WS Shamban with Hank Traub to develop PTFE compounds with improved wear resistance using special fillers. Besides glass fiber and carbon they discovered the unique turquoise additive, the color that has become synonymous with PTFE-based

Turcon® branded seals. The first seals were developed for the fast growing aerospace market.

In 1965 Bill's new company in Denmark produced Turcon® Seals for Europe. Busak+Luyken, a German engineering company, started to promote the seals in Germany and, in 1972, jointly developed the world's first leak-free rod seal, the Turcon® Stepseal®, with the University of Stuttgart.

In Germany and elsewhere, the Turcon® seals were highly successful and, in 1992, Busak+Luyken and Shamban merged to become Busak+Shamban. The company then became part of Trelleborg Sealing Solutions and is now the world's leading developer of PTFE thermoplastic seals.



# Sealing the aircraft

Every time you fly, you're probably relying on seals and airframe components from Trelleborg Sealing Solutions to help make your flight safe.

Trelleborg's pedigree in developing and manufacturing seals for aircraft goes back over 60 years, and the company is now the world's leading supplier of sealing solutions to the aerospace industry. Our products are on virtually every major plane platform flying globally, performing in a wide variety of systems including flight controls, actuation, landing gear, wheels, brakes, fuel controls, engines and airframe.

Trelleborg is uniquely placed to offer a dedicated seal design and development service to the aerospace market. Our experienced engineers are able to contribute their knowledge directly to customers. Dedicated teams are appointed to manage the supply process from concept through production, testing and installation of sealing systems.



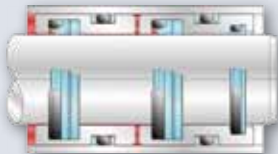
**Windows and Doors**  
Airframes provide a vital seal for windows and doors. Performing technically, they must meet strict aesthetic requirements where required.

**Nose Gear**  
Seals ensure effective movement in steering actuation systems.

**Belly Fairings**  
Aerodynamic interface between fuselage and wing utilizes many seal geometries and provides a complete sealing solution.

**Fuel System Pumps and Fuel Lines**  
Fuel resistance and operation at low start-up temperatures are requirements in these applications.

**Landing Gear**  
Safety is ensured with seals that stand up to high shock loads and deflections. These are used in landing gear systems, retraction actuators, up-locks, down-locks, truck position and door actuators.



**Wheel & Brake**  
Seals within these systems must exclude external media while withstanding high pressures and temperatures.



## Trimmable Horizontal Stabilizer Actuators (THSAs)

These large, complex Secondary Flight Controls (SFC) rely on rotary seals for operational performance.

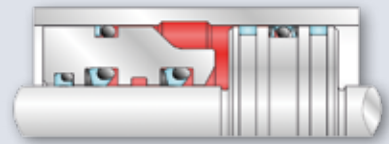
## Flight Controls

Our products feature in all primary flight control applications such as the ailerons, elevators, spoilers and rudder actuators. The sealing systems provide leak-free operation at extremes of temperature, duty cycles and pressures up to 34 MPa/5000psi. Materials are developed to perform on the latest surface coatings, including High Velocity Oxygen Fuel (HVOF) applied coatings.

## Nacelle and Thrust Reverser System



Nacelles are designed to ensure optimal performance of the aircraft and engine. Within them are numerous sophisticated sealing configurations. The nacelles incorporate the thrust reverser and its actuation system (TRAS). Meeting the pressure and temperature requirements within the nacelle, seals are engineered for compliance with international safety standards.



## Wings

Airframe seals are used throughout the wings, including the flaps and slats.

## Utility Systems

Robust seals for cargo and fan cowl doors.

## Engines



Seals such as annulus filler seals are designed to meet critical aerodynamic functions. Other seals are designed in Isolast® materials to operate at extreme temperature.

Specialized gaskets in graphite are ideal for applications such as engine casings.

## High-Lift System

Seals in this Secondary Flight Control (SFC) system perform in dynamic rotating applications throughout the life of the aircraft.

# Bottling

## it

Trelleborg Sealing Solutions helps Tech-Long's blow molding machines work longer and more effectively.

The blow-molding machine's dispenser where sealing is critical.



One area where business is booming is food and beverage processing. The global demand for food and beverages reached 11.6 trillion US dollars in 2009 and is likely to reach 15 trillion in 2014\*. That means an increasing need for packaging, including plastic bottles.

To meet the need for higher volumes, production equipment is continually being improved. It's becoming faster and more efficient all the time. Not only is it a matter of increased production yield, but also meeting health and safety standards that are becoming more stringent all the time.

### Maximizing production while minimizing downtime

Chinese company Guangzhou Tech-Long is the largest manufacturer of PET (polyethylene terephthalate) bottle blow molding machines in China.

"We are continually trying to offer our customers machines that maximize production capability while minimizing downtime for maintenance," says Zou DaQun, Technical Director of Tech-Long.

"We have a good relationship with Tech-Long," says Nelson Chow, Trelleborg Sealing Solutions Sales Engineer in China. "When the company was developing its latest range of equipment it approached us, as an established supplier, to provide a sealing solution."

### The sealing system in the blow molding machine's dispenser is critical

In the center of a blow molding machine is its dispenser. This is the core part of the machine and its seals are critical. If they fail, this can lead to high costs due to lost production time. The sealing system within the dispenser needs to operate in 1 to 4 MPa/ 145 to 580 psi dry air pressure at rotational

## About Tech-Long

Guangzhou Tech-Long Packing Machine Co., Ltd. specializes in developing high-grade beverage packaging equipment and is the leading enterprise of its kind in China.

The company is located in the Luogang District of Guangzhou, occupying an area of 145,000 square meters/ 173,419 square yards with more than 700 employees. Its products are sold in 48 countries and regions and are used by major beverage makers throughout the world.



There is an increasing need for packaging, including plastic bottles.

Research and development is key to Tech-Long and 200 professional technical developers are employed in its R&D center. Due to Tech-Long's technology its products not only sell well in the home market but are also exported to North America, Southeast Asia, Europe and Africa.



Guangzhou Tech-Long is the largest manufacturer of PET bottle blow molding machines in China.

speeds of 150 mm/s/ six inch/s non-stop for between 16 to 20 hours per day.

“Dry air is a difficult medium to seal,” continues Nelson. “To successfully do this the seal must initially demonstrate a very smooth and tight dynamic sealing surface after a short run-in. It must then have outstanding wear resistance in poorly lubricated conditions.”

To achieve optimum performance the choice was a specially developed Turcon® compound, the Trelleborg Sealing Solutions proprietary polytetrafluoroethylene (PTFE) based sealing material. A number of seals were specified including a custom Turcon® Roto Glyd Ring® with its unique pressure relieving function.

### Professional technical services and solutions

“Trelleborg Sealing Solutions is a very good partner to Tech-Long,” says Zou DaQun. “They do not just sell products but more importantly provide professional technical services and solutions. That is what Tech-Long is really interested in and why we have been in cooperation with Trelleborg for 10 years continuously.”

Sealing configurations from Trelleborg Sealing Solutions are now successfully operating in Tech-Long PET bottle blow molding machines globally. Tech-Long and Trelleborg Sealing Solutions continue to work together on new developments.

\* Source: Frost & Sullivan Global Food & Beverage Industry Outlook – 11.6 trillion U.S. dollars = 8.5 trillion EUR, 15 trillion U.S. dollars = 11 trillion EUR

# Turcon<sup>®</sup> M12 - A universal answer



Key to achieving maximum seal life is to make sure that sealing compounds match up to application parameters. If a material can stand up to a greater variety of conditions, this makes the compound more versatile. That's why Turcon® M12 is a revolution in hydraulic sealing.

"Turcon® M12 is a big step forward in PTFE based compounds for use in hydraulic, or, as they are sometimes termed, fluid power applications," says Søren Roepstorff, Development Manager at Trelleborg Sealing Solutions Helsingør.

### Continued PTFE development

Trelleborg Sealing Solutions has an unrivalled pedigree in polytetrafluoroethylene (PTFE) development. "We were the first company to recognize the potential of PTFE as a sealing medium," continues Søren. "Turcon® M12 continues that long history."

Considerable R&D time has been devoted to develop a PTFE based material that is compatible with a broad range of lubricants. It also had to demonstrate minimal wear with excellent friction characteristics at extreme temperatures, high pressures and rapid velocities.

### A dream PTFE material

"We put our specification together for a dream PTFE material, one that could fit virtually all hydraulic applications," says Gert Iversen, Manager Product Engineering at Helsingør.

"We have achieved this with Turcon® M12. That means our customers' products can meet a more universal range of applications, which is a major advantage."

On the face of it the issue that Turcon® M12 is designed to tackle may not appear to be very important. But, to any manufacturer of hydraulic equipment this development is a significant one.

### The wrong seal in the wrong place can cause problems

To maximize the life of a hydraulic actuator or cylinder, for instance, the manufacturer must be sure that the internal components, especially the seals, are compatible with the system hardware like the mating surfaces, media and operating pressure and temperature. Up until now, due to the limitations of fillers in current PTFE based sealing compounds, this meant that hydraulic equipment must be specifically matched to particular applications. If not, shortened component life could occur, or even total failure.

"The problem is that often hydraulic equipment manufacturers do not know where their equipment ends up," says Holger Jordan, who heads up the fluid power technology department within the R&D department at Trelleborg Sealing Solutions in Stuttgart. "Then they may see unexpected returns and the seal, which is often viewed as potentially the weakest part of the component, is blamed."

### Versatility of Turcon® M12 alleviates compatibility problems

"When we investigate though, virtually without exception we find that the equipment has been used in an application differing from the original specified. Often, tribologically critical media or changing roughness of the counter surface has caused the seal failure. The versatility of Turcon® M12 alleviates this problem."



### In short...

- To achieve maximum seal life, sealing compounds must match up to application parameters.
- The wrong seal in the wrong place can cause problems.
- The new Turcon® M12 is the universal choice in PTFE materials.

Before its launch, Turcon® M12 was put through its paces in the research lab, undergoing an extensive test program comparing it to the best-in-class compounds, against important sealing parameters.

### Results beyond expectations

“The new material has exceeded even our expectations,” says Holger “On every parameter

it has come out as comparable with the previously recommended compounds and in most cases, has bettered them, sometimes very significantly. Despite the outstanding performance of many of our sealing materials, we don’t often stand up and say that this is the best in market. But Turcon® M12 is truly unrivalled.”

#### M12: The result of an intensive cooperation

Trelleborg Sealing Solutions is a major force in seal and sealing compound development. We have R&D teams, material labs and product engineering located at key points throughout the world collaborating on creating products to meet the continually changing needs of customers.

The original idea for Turcon® M12 came from the center of excellence for PTFE based materials, Helsingør in Denmark. The resulting material is the product of a long-term collaboration between material development and product engineering in Helsingør and the R&D laboratory in Stuttgart, Germany.

#### Tests prove Turcon® M12’s universal appeal

Trelleborg Sealing Solutions has the most comprehensive range of polytetrafluoroethylene (PTFE) based sealing materials for hydraulic applications. Back-to-back tests against these have confirmed the universal nature of Turcon® M12. In most cases, it is comparable with the best material against each sealing parameter, and in some cases exceeds the performance of the previous best-in-class. This proves Turcon® M12 to be the only material on the market that can demonstrate such excellent performance over such a wide range of parameters, making it the universal answer for hydraulic sealing applications.

## Features and benefits of Turcon® M12

**The Turcon® M12 matrix is medium-filled with a complex mix of non-abrasive mineral fibers combined with additives.**

- Sealing material for universal use in hydraulic applications
- Resistant to virtually all media including a broad range of lubricants
- Outstanding wear resistance and friction characteristics
- Provides extended seal life
- Operates in wide temperature, pressure and velocity ranges
- Minimal abrasion of hardware, preventing damage to counter surfaces
- Robust for harsh environments
- Good resistance to extrusion
- Less environmental impact as it does not include bronze fillers
- Reduced stock holding and fewer items to handle
- Cost-effective solution





# Key applications

**Turcon® M12 is the material of choice for a wide variety of hydraulic applications.**

Application		Turcon® M12 advantages
<b>Fluid power</b>	Hydraulic cylinders and actuators	Compatible with all types of hydraulic fluid, especially those fluids with low lubrication performance
	Giant cylinders	Low abrasion
	Hydraulic jacks	Low friction for frequent movement
	Clamping cylinders	Avoids hardware damage on counter surface
<b>Hydraulic machinery</b>	Machine tools and machining centers	Low friction and suited to short stroke linear movement. Compatible with all types of hydraulic fluid, especially those fluids with low lubrication performance
	Injection molding machines	Withstands constant activation
	Hydraulic presses	High wear resistance. Compatible with all types of hydraulic fluid, especially those fluids with low lubrication performance
	Press brake and punching machines	Operates under high pressure
	Steel and rolling mills	Heavy duty
<b>Wind power</b>	Hydraulic pitch cylinders	Extended seal life reduces maintenance
	Turbine piston accumulators	24-7 operation
<b>Automotive</b>	Pistons for convertibles	Avoids damage to counter surfaces
	Shock absorbers	Low friction gives smooth movement
	Active body control	Low friction gives smooth movement. Withstands high system pressure
<b>Mobile hydraulics</b>	Lifting and telescopic cylinders	Withstands harsh environments
	Active suspension and stabilizer cylinders	Complex back to back seal arrangements optimize performance
<b>Rail</b>	Shock absorbers	Robust for difficult environments

# Detailed results of tests

Turcon® M12 and other PTFE based sealing compounds were used to produce Turcon® Stepseal® 2K, Turcon® Twinseal, Turcon® Stepseal® V and Slydring®. The seals underwent a

number of stringent test regimes to measure performance against a variety of sealing parameters critical to the effective performance of seals within hydraulic applications.

## Test

**Compatibility with mineral oil and bio oil**

**Friction mapping – performance at different pressures and speeds**

**Friction force Slydring®**

## Details

<b>Lubricant:</b>	Mineral based HLP 46 cSt. Synthetic ester-based, biodegradable fluid, 46 cSt.	Equivis ZS 46, viscosity 46 cSt. mineral oil	Equivis ZS 46, viscosity 46 cSt. mineral oil
<b>Cycles:</b>	200,000	30,000	100,000
<b>Stroke length:</b>	280 mm/ 11 inch	200 mm/ 8 inch	250 mm/ 9 inch
<b>Total length:</b>	112 kilometers/ 70 miles	12 kilometers/ 7.5 miles.	50 kilometers/ 31 miles
<b>Pressure:</b>	30 MPa/ 4,351 psi cycle on both sides of the test cylinder	10 to 30 MPa/ 1,450 to 4,350 psi cycle on both sides of the cylinder	Constant 2.5 MPa/ 362 psi <b>Side load:</b> 8 N/mm <sup>2</sup>
<b>Velocity:</b>	0.20 m/s/ 0.66 feet/s	Between 0.05 m/s/ 0.16 feet/s and 0.30 m/s/ 0.98 feet/s	0.20 m/s/ 0.66 feet/s
<b>Temperature:</b>	+55°C to +60°C/ +131°F to +140°F	+55°C/ +131°F	+50°C/ +122°F

## Result

**Results in mineral oil:**

Turcon® M12 matched the best-in-class materials and demonstrated the lowest friction force of all compounds. In addition, it had the smallest reduction in seal profile height, giving the lowest overall wear and deformation.

**Results in bio oil:**

Bio oils can be a difficult media for seals to operate in. In this test some compounds showed unacceptably high leakage. Turcon® M12 gave outstanding results with minimal leakage and the friction force of Turcon® M12 was extremely good with excellent stability. Reduction in radial height of the profile was comparative with best-in-class materials and extrusion was acceptable. Turcon® M12 is now recommended as the material of choice for use with bio oils.

In these tests the seal must operate within the opposing effects of pressure and velocity. As pressure increases, the contact area between the seal and the rod increases and friction becomes higher. At higher velocities, friction is reduced as the coefficient of friction is decreased by a higher oil film formation.

At all pressures and velocities, Turcon® M12 had the lowest friction force.

In this test, the friction additives in Turcon® M12 demonstrate their positive effect and, after the run-in period, the friction is lower than for all other compounds tested. The material had the combined lowest wear and deformation, leading to extended life of the seal.



# Turcon® M12

	High-pressure wear test	Wear test – wind power specification	Wear test – hydro pulse
<b>Lubricant:</b>	HLP 46, zinc-free mineral oil	HLP 46, zinc-free mineral oil	HLP 46, zinc-free mineral oil
<b>Cycles:</b>	1 million	1 million cycles both ways at a constant pressure	1.3 million in 24 hours
<b>Stroke length:</b>	300 mm/ 12 inch	20 mm/ 0.8 inch	+/- 5 mm / 0.2 inch
<b>Frequency:</b>	–	1Hz	Up to 15Hz
<b>Pressure:</b>	4 to 36 MPa/ 580 to 5,221 psi	20 MPa/ 2,900 psi	15 MPa/ 2.175 psi
<b>Velocity:</b>	0.14 m/s/ 0.46 feet/s (average, sine signal)	–	–
<b>Temperature:</b>	+80°C/ +176°F	+80°C/ +176°F	+60°C/ +140°F

These are extreme requirements for a seal, especially in zinc-free oil. The seals in Turcon® M12 showed virtually zero wear with no micro-scratching. The material performed better than any other Turcon® compound in this test.

The chrome plated surface of the rod was only slightly polished with no micro scratching and no extrusion. Roughness values stayed very constant, which enabled the tribological system between seal contact area and counter surface to run in a defined area. The surface of the seal in Turcon® M12 showed virtually no wear.

This test proved that Turcon® M12 prevents counter surface scratching. Even after 1.3 million cycles the grinding pattern is still visible on the rod with only slight polishing of the metal surface and no micro-scratching. Turcon® M12 is particularly suited to applications where there are short-stroke, high-frequency movements.

Note: All tests were performed with a ø 50mm/ 2 inch hard chrome-plated rod.

# FSI:

## FORENSIC SEAL INVESTIGATION

Forensic examination of seals is an essential part of investigating the true causes of seal failure. Trelleborg's meticulous approach to laboratory based science helps to unravel the history of damaged seals using even the smallest items of evidence.



# ENSI

In a large scale European agri-business, heavy duty hydraulically operated equipment is essential to a farm's efficiency and speed, from plowing, planting and harvesting the crop to baling the hay and creating silage. The farmer, the equipment manufacturer and the supplier of hydraulic oils all depend on the efficiency and power of hydraulics.

So when a seal failure in a main cylinder makes an expensive and essential piece of capital equipment idle, at the beginning of harvest, the farmer, seal supplier and oils distributor are understandably concerned.

This was the case when a failed seal arrived in a package with a short letter of explanation on Mark Reuter's desk at Trelleborg's Polymer Laboratory in Stuttgart, Germany.

To the engineering eye, the seal was obviously misshapen and damaged – how had this happened, and could an answer be found which would stop it from happening again?



**“There were a number of lines of investigation which could be followed up here,” said Mark. “Firstly, we needed to know about the circumstances, the actual scene of the crime, one could say. These could have a very important contribution to the cause of the incident, and how we could go about finding a solution.”**

One key part of the investigation is checking the essential physical and chemical performance characteristics of the seal compound against the

operating conditions of the hydraulic equipment. As seals do not always carry identification marking, this needs a full analysis of the seal's physical properties to see if they match a known set of properties from around 5000 different Trelleborg materials. If they don't, then it is likely that the seal was supplied by another manufacturer.

**“Seals may fail for a number of reasons, and the most frequent is incorrect specification for the application,” points out Mark. “If it is our seal, then mis-specification is easier to discover; if it is not our seal, this can be difficult but our experience and analysis often allows us to suggest a likely cause.”**

So while the detailed analytical examination procedures began, the laboratory contacted the manufacturer and asked for some more details about the application parameters.

From the reply, it appeared that the application was standard, well within the seals' pressure, lifetime and temperature limitations. Only two details stood out; the interaction of these was very significant and provided a strong clue for further investigation.

First, the hydraulic oil involved was biodegradable. EU environmental directives encourage every effort to reduce pollution. Therefore, industries which operate in sensitive environments, such as forestry or around water and agriculture, are required to use biodegradable hydraulic fluids to minimize the effects of spillage and leaks.

Biodegradable oils are not always compatible with rubber-based elastomers. The composition of biodegradable oils is quite variable, and care is needed in matching the oil used to the material; changing the oil without checking the seal specification can lead to failure.

The second factor was that the customer had two sources for his hydraulic seals, as is normal practice to guarantee continuity of supply; Trelleborg and another manufacturer both supplied seals to the specification involved.

It was known that the Trelleborg seal specification supplied to the customer should have been resistant to the biodegradable oil used. But, the

# C SEAL INVESTIGATION

question was, whose damaged seal was returned to Trelleborg? After a series of tests, the thermogravimetric and FTIR spectroscopy procedures clearly showed that the seal did not match any of Trelleborg's known material profiles and was, therefore, from another manufacturer.

So what was the actual elastomer material used? And, more to the point was it compatible with the fluid used?

Apart from being a grade of nitrile, the exact physical specifications were very difficult to pinpoint. The trials clearly showed degeneration of the material which would have quickly downgraded its elastomeric sealing characteristics. The Trelleborg seal supplied to the customer was tested in the same fluid and showed significantly greater resistance, well within specification.

**"Unfortunately, we have encountered this situation before,"** advises Mark. **"A purchasing department very**

**conscientiously finds an alternative source. However, insufficient understanding, or experience, of the specification requirements can lead to a poor result."**

Where a material has a lower specification, it is usually less expensive, which is always an attractive incentive to buy. But, for the sake of a few tiny savings, the equipment becomes inoperative and can suffer damage; its work could be halted at a critical time leading to loss of revenue. Catastrophic failure could also be a health and safety danger and even the loss of biodegradable oil to the environment is undesirable.

**"In this case, we made a report with our conclusions to the customer and their hydraulic oil supplier,"** concluded Mark. **"We suggested that the customer look again at matching seal specifications with the fluid used and offered our continuing technical support; a lot of leakage in the field could be avoided if the compatibility of the seal with the used hydraulic fluid is tested before."**

## Forensic seal investigation process

### Objectives

To obtain a physical and chemical properties profile which allows the engineers to:

- identify the seal
- investigate what happened to the seal
- suggest what could be done to improve the specification and prevent failure happening again

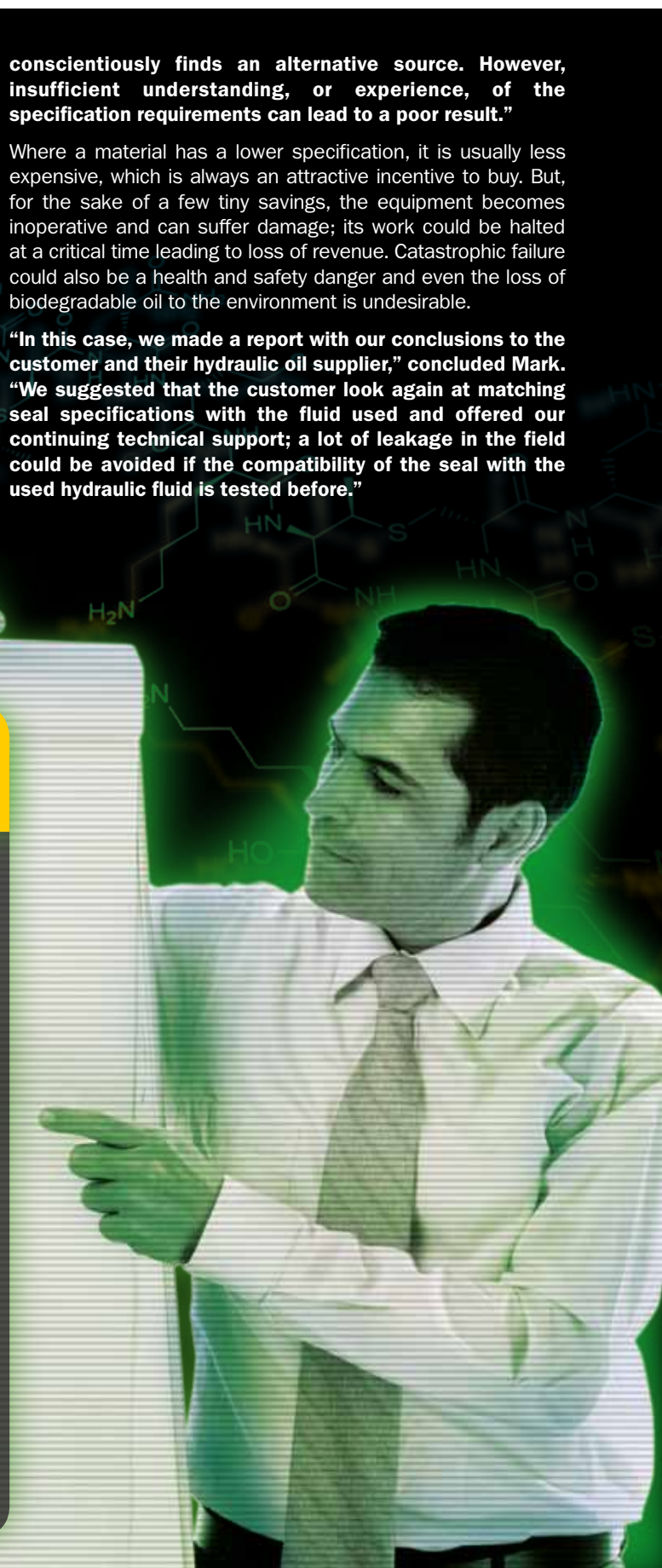
### Procedure

Obtain samples and fluids that were in contact with the seal. Physical and chemical examinations to identify the seal, including:

- Hardness, tensile strength and elongation at a range of ambient and elevated temperatures
- Specific cold testing as this can have lasting effects on elastic properties
- Thermogravimetric analysis
- FTIR spectroscopic analysis

### Result

The unique profile, established from the results, acts as a footprint for a specific seal, and also allows some broad conclusions to be reached about its likely performance.



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The demand for greater cleanliness in many major industries is leading Trelleborg to develop its own standards which cross sector boundaries.

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# Seals clean up



“The demand for greater cleanliness in many major industries is leading Trelleborg to develop its own standards which cross sector boundaries,” says Simone Frick, Product Manager Surface Finishing for Trelleborg Sealing Solutions

Industrial product specifications are becoming more demanding. They require greater precision and higher performance with better efficiency, lower wear and less maintenance.

This places critical pressure on the manufacturing quality standards of the components such as seals. Industries such as automotive, electronic and electrical, aerospace, food and beverage processing and pharmaceutical manufacturing now require ultra-cleanliness. Manufacturing tolerances are becoming so fine that every effort must be made to eliminate contaminating foreign material that might affect operation.

## Different demands

Each industry, and many manufacturers, have different interpretations of the term ‘clean.’ For example, clean for seals could mean no grease or oil, fingerprints, micro-organisms or residual dirt contamination.

Trelleborg Sealing Solutions can manufacture seals in cleanroom environments if required.

And by the term 'No' do we mean absolute zero? This is a level that is virtually impossible and uneconomical to achieve. Or is cleanliness specified against a specific set standard, such as particles per square meter or per item?

"It is more realistic to specify cleanliness to specific standards," comments Simone Frick. "Absolute cleanliness is not really achievable."

### Clean in real situations

Typical residual contamination from a standard fitted seal that is normally accepted as clean could include machined metal residues (swarf), textile derived traces, particles, sticky greases or oils or cleaning chemical residues. Of course, these can come from other sources than the seal manufacturer; contamination can also occur during subsequent handling and the seal fitting process.

So it is frequently difficult to establish an acceptable definition for clean. What do customers mean when they demand clean seals? To define the exact requirements for a specific manufacturing process, careful discussion is usually needed between the supplier and customer.

### The limits of cleanliness and in-house standards

The science and application of technical cleanliness for seals is a challenging, dynamic and developing field. For the highest cleanliness levels, there are technical and commercial limits to what can be attained, which must be balanced with realistic specifications and expectations by the customer.

"The internal Trelleborg standards have been devised to help the company cover a very wide range of external cleanliness

requirements," adds Simone Frick. "This represents best industry practice."

Given the diversity in requirements from different industries, Trelleborg felt that it was more realistic to create a range of industry standards based on the best standards for a specific sector and application.

For example, PWIS silicone-free and oil- and grease-free requirements are met by a Trelleborg standard, which is based on one of the most rigorous automotive manufacturer test specifications, while incorporating elements from other manufacturers.

For Cleanroom Class X requests, the cleanroom itself has to meet the specified verification process, as 'washed and packed in Cleanroom Class 5 (ISO 16444-1)'. As well as a clean manufacturing environment, residual contamination is removed according to internal standards, based on ISO 16323 / VDA 19, using the pressure rinsing method.

### Keeping it clean from start to finish

Careless handling between seal manufacturing and installation by the customer can undo all the investment in clean manufacturing facilities and procedures. Maintaining strict cleanliness conditions can be regarded as a state of mind and careful training. Cleanliness and cleanliness procedures should be the responsibility of both parties.

Through its development work in establishing high cleanliness standards for its products to meet requirements across industry sectors, Trelleborg is committed to clean manufacturing to assist its customers in achieving new standards of performance and efficiency in their own products.

## Key points on cleanliness

### ● Silicones, oils and paint wetting impairment substances:

This covers a wide range of contaminants including oils, greases, resins and resilient substances which may also be Paint Wetting Impairment Substances (PWIS). These could affect the performance of a thin film of paint or varnish, for example as an insulant in electronics.

However, achieving a totally silicone-free state is not really possible and the exact requirements of a specification should be carefully investigated.

### ● Cleanroom to specified Class standards:

Cleanrooms are controlled atmosphere environments where the primary requirement is to reduce the particle count per volume (ISO 14644-1) of the internal atmosphere, and minimize added contamination. The current most usual specification is 'washed and packed in Cleanroom Class 5' to ensure seals are produced under

these conditions; this latest EU standard is similar to the previous US Federal Standard 209E Cleanroom 100, which expired in 2001.

### ● Free of residual or visible contamination:

This should be precisely defined to include maximum particle size, distribution, type and weight and specific analysis methods, including those in the ISO 16232 and VDA 19 standards.

### ● Clean auto engines:

Increasing performance requirements in the automotive industry makes cleanliness of components like seals very critical. In addition, the EU is phasing out the use of lead in bearings from 2011. The replacement is less tolerant of small particle contamination, so components must be cleaner to avoid compromising the lubricant film in metal-to-metal sites.



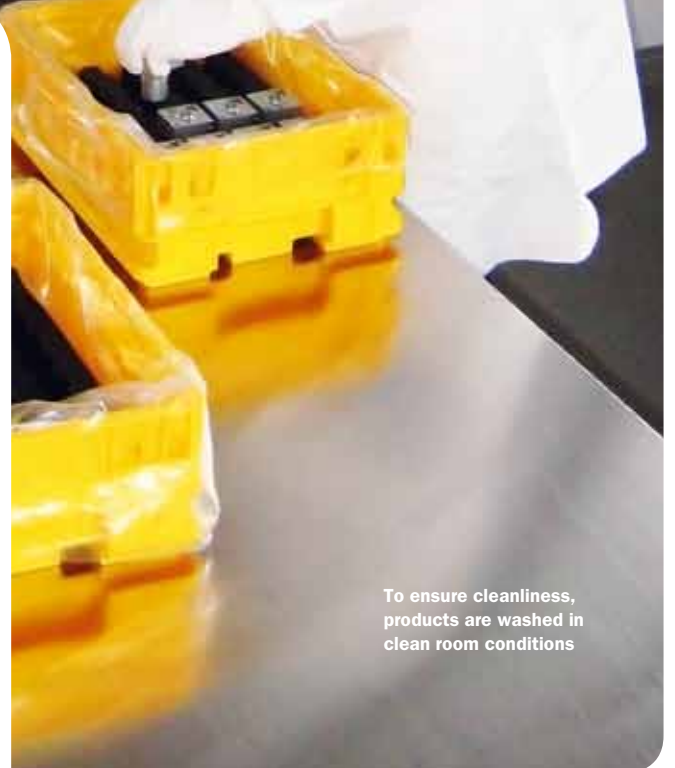
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The internal Trelleborg standards have been devised to help the company cover a very wide range of external cleanliness requirements.

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Paint flaws, such as these, are a result of contamination in the painting process.

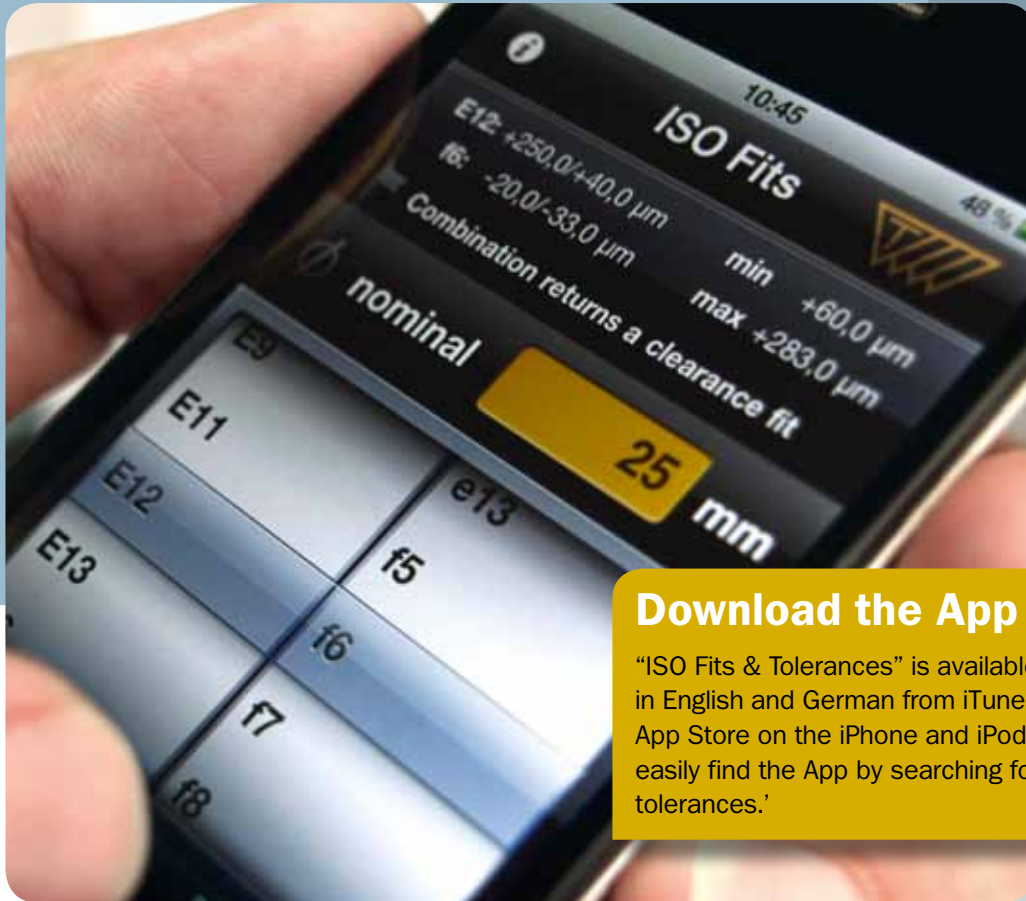


To ensure cleanliness, products are washed in clean room conditions

# Why sit still when

Review of the new iPhone app by Wendy Sack,  
Marketing Communications Manager for the Americas

# you can



## Download the App now!

“ISO Fits & Tolerances” is available free of charge in English and German from iTunes or via the Apple App Store on the iPhone and iPod Touch. You should easily find the App by searching for ‘Trelleborg tolerances.’

I don't know about you, but my life seems to be getting more and more hectic, personally and professionally. As I work in communications, it's part of my job to keep all of our engineers up-to-date and support them on a moment's notice. I can only imagine what it must be like for them.....

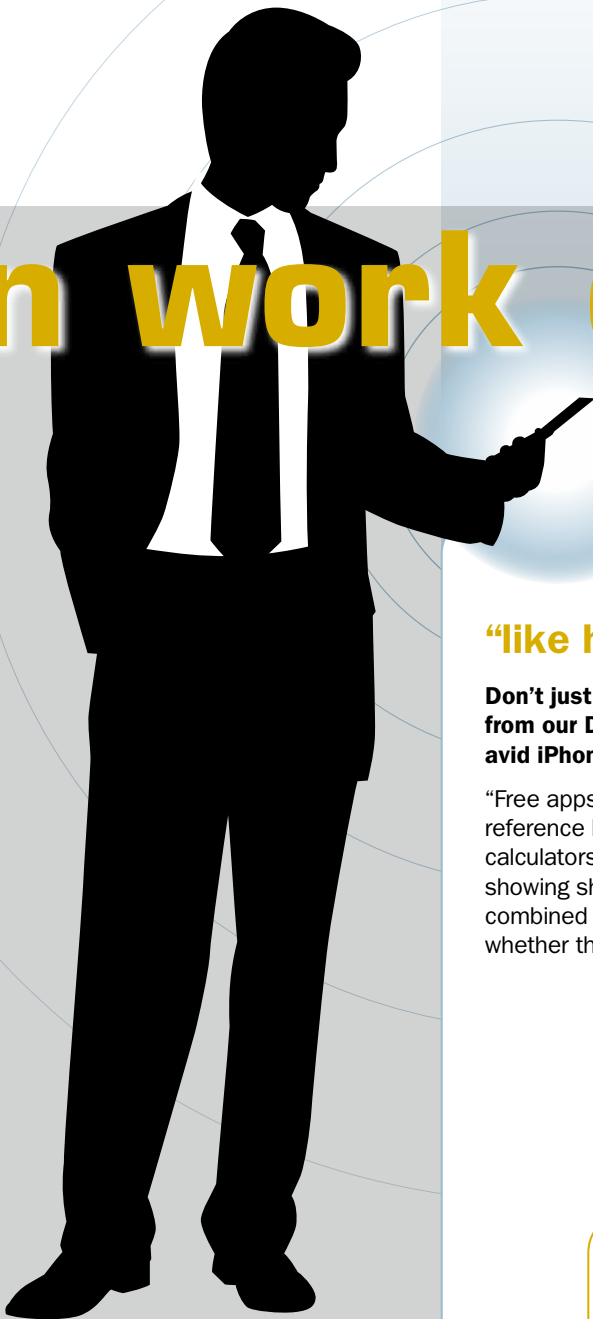
As an engineer, your time is valuable. Picture it: You're walking through the airport, perhaps in a rush to make it to your gate on time. Your phone rings. It's a client, and he needs your help. He's under the gun to finish a print, but can't find the ISO tolerance standards that he needs. There's no time to power up your laptop, so what are you going to do?

Well, if you have the new Trelleborg Sealing Solutions iPhone app for engineers, no need to worry! “ISO Fits & Tolerances” is in the palm of your hand, meaning the answer to your need is right at your fingertips.

“ISO Fits & Tolerances” is intuitive and very easy to use. Upon entering the nominal diameter needed, users simply select the tolerance classes for bore and shaft. The app then provides the complete ISO fits definition with all relevant values including the type of fit. Tolerances are shown for the most commonly used ISO tolerance classes, and convenient graphs illustrate these classes by bore and shaft. The new app provides results based on the ISO 286 System of Limits and Fits.

Also included with the app is one-touch access to the automatically updated library of Trelleborg Sealing Solutions films and animations on YouTube. For more information, just click ‘Contact’ and you can choose to email or be connected to the Trelleborg Sealing Solutions website.

# Can you work on the go?



## “like having a reference book in your pocket”

**Don't just take my word for it; let's hear from our Director of Technology, and avid iPhone user, Colin Macqueen:**

“Free apps like this are like having a reference book in your pocket. The calculators are fast and easy to use, showing shafts and bores separately or combined with a clear statement on whether the result is a clearance, an

interference or a transition fit. Once a nominal size has been entered, different classes of tolerance can be selected and the result viewed immediately. Trelleborg Sealing Solutions has developed this app to aid engineering in designing fits for sealing applications, but I can see it being used in a wide range of design situations, whether related to sealing or not.”

**This app is very user-friendly. Any engineer with an iPhone could pick this up and use it with ease.**

**The familiar rolling selection of the iPhone and iPod is used here as well.**

## Check out the screencast of the iPhone App

Just click on the iPhone or the play button to start the film. To see the film Acrobat 5 or higher and Flash player need to be installed on your computer.

Trelleborg Sealing Solutions introduces HiMod® FlatSeal™, a range of best-in-class gaskets that complements Trelleborg’s market-leading sealing product offering.

# Flatly eff

“We are seeing a trend for our customers to reduce their supplier bases,” says Ralf Gergen, project leader for introduction of HiMod® FlatSeal™ into industrial applications. “They like the service Trelleborg Sealing Solutions provides for other sealing products and we are often asked for flat gaskets. The new HiMod® FlatSeal™ range of flat gaskets is best-in-class and will complement our product portfolio.”

“We’ve designed the range to be well balanced, meeting the majority of the needs of those original equipment customers who want flat gaskets,” says Michael De Luca, project manager for HiMod® FlatSeal™ developed for the aerospace market.

According to De Luca the flagship is HiMod® FlatSeal™36. “This gasket has the best pressure to temperature ratio of any gasket on the market,” he says. “It can be used universally in a wide variety of areas of the aerospace, chemical and processing industries at temperatures up to +550 °C/ 1,020°F. This will help our customers standardize gaskets throughout their plants.”

Trelleborg Sealing Solutions is committed to provide outstanding service and one way in which they can do this for gaskets is to provide rapid delivery of prototypes.

“We’ve invested in leading-edge technology in our manufacturing facility in Condé, France,” continues Gergen. “Our oscillating-knife cutting machine has a reduced set-up time. That means in most cases, when requested at quotation, samples can be submitted together with the offer.”

The facilities also comply with ISO/TS 16949 and ISO 14001. This means complete transparency in all areas of production and a high degree of security for our customers.



## In short...

- Trelleborg launches new HiMod® Flat Gasket™ product range.
- Flat gaskets are usually fitted in flanges and are widely used in sanitary and industrial applications.
- Industries served include Aerospace, Oil & Gas and Food, Beverage and Pharmaceutical.

## Overview of HiMod® flat

10

### A good all rounder

Suitable for a broad variety of standard applications, this gasket is ideal for use in average temperatures and pressures.

15

### Ideal for steam, oils, fuels and hydrocarbons

This gasket shows exceptionally good resistance to steam and fluids such as oils, fuels and hydrocarbons.

### The new range consists of seven products that will satisfy the requirements of the majority of applications.

Flat gaskets are primarily fitted in flanges and widely used in sanitary and industrial applications. For the more demanding petrochemical and chemical processing sectors, superior materials that are compliant with blow-out and fugitive emission regulations are offered. While for food and beverage applications, materials compliant with stringent food contact standards such as FDA, are provided. In addition, in the aerospace industry flat gaskets are fitted in bleed air, pressure and condition systems, as well as pipes, ducts and bellows.



# ective

## gasket range

20

### Long-term resistance to high pressure

Providing high long-term pressure resistance, this gasket is also blowout resistant and complies with fugitive emissions standards.

34

### Easier handling and strong performance

For universal use in a wide variety of general and chemical processing applications, the gaskets metal insert guarantees easy handling and a strong performance.

36

### Maximum safety and standardization throughout the processing plant

The gasket's unique material profile offers the best pressure to temperature ratio of any gasket on the market allowing standardization throughout a processing facility.

43

### Superior performance in food applications

Suitable for food contact, the gaskets offer improved performance compared to conventional polytetrafluoroethylene (PTFE) flat gaskets.

45

HiMod® FlatSeal™

### Exceptionally resistant

All of the materials within the HiMod® FlatSeal™ range have been chosen for their excellent blowout and fugitive emissions resistance.



# HiMod<sup>®</sup> FlatSeal<sup>™</sup>



HiMod<sup>®</sup> FlatSeal<sup>™</sup> 10

**Elements:**

Aramide fibers, functional fillers and NBR (Nitrile Butadiene Rubber)

**Color:** Orange

**Features and benefits:**

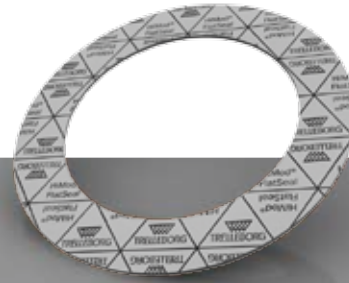
- Good media resistance and stress relaxation
- Ideal for use in average temperatures and pressures
- Leakage less than limits specified in DIN 3535-6
- Anti-stick coating on one side

**Applications:**

- Gas and water supply (sanitary engineering)
- Pipeline construction
- Plant construction and maintenance
- Machine manufacturing

**Approvals:**

DVGW, KTW, VP-401, W270, WRAS



HiMod<sup>®</sup> FlatSeal<sup>™</sup> 15

**Elements:**

Glass fibers, functional fillers and NBR (Nitrile Butadiene Rubber)

**Color:** Silver gray

**Features and benefits:**

- Ideal for use in medium to high temperatures and pressures
- Outstanding mechanical strength
- Leakage less than limits specified in DIN 3535-6
- Exceptionally good resistance to steam and fluids such as oils, fuels and hydrocarbons
- WRAS approved for use in hot and cold potable water
- Anti-stick coating on one side

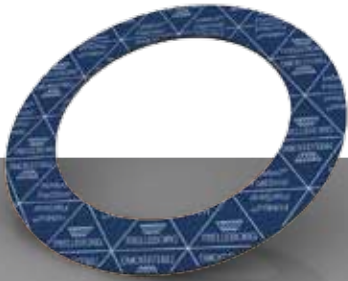
**Applications:**

- Aircraft gear boxes, pumps, hydraulic systems and actuators
- Instrumentation
- Pumps, valves, compressors, drives and engines
- Gas and water supply including heating (sanitary engineering)
- Pipeline construction
- Plant construction and maintenance
- Machine manufacturing

**Approvals:**

BS7531, DVGW, KTW\*, BAM\*, TA Luft, WRAS\*

# 20



HiMod® FlatSeal™ 20

**Elements:**

Graphite, aramide fibers, Kevlar®\*\* and NBR (Nitrile Butadiene Rubber)

**Color:** Royal blue

**Features and benefits:**

- Very high long-term pressure resistance
- Compatible with a high proportion of media commonly used in the chemical industry including oils, greases, acids, alkalis, solvents, refrigerants, water and steam
- Good temperature resistance
- Extended life reduces intervals for planned maintenance
- Compensates for flange unevenness and roughness
- Environmentally-friendly solvent-free
- Leakage less than limits specified in DIN 3535-6
- Blowout resistant
- Complies to fugitive emissions standards

**Applications:**

- Petrochemicals
- Chemical processing
- Plant construction and maintenance
- General industrial applications

**Approvals:**

DVGW, KTW, BAM\*, VP-401, WRAS, W270, TA Luft

# 34



HiMod® FlatSeal™ 34

**Elements:**

Gasket material made of expanded graphite with a purity of 99 percent minimum reinforced with a stainless steel wire mesh insert (material no. 1.4301/AISI 304.)

**Color:** Gray

**Features and benefits:**

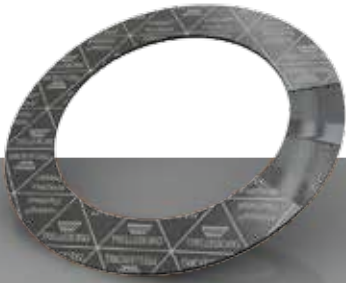
- Metal insert guarantees easy handling before installation and a strong performance in the flange
- Operating temperatures from -240°C to +550°C/ -400°F to +1,022°F
- Withstands extreme pressure up to 150 bar/ 2,175 psi
- Suitable for use in extreme charging loads and cycles
- Compatible with practically all organic and inorganic acids, alkalis, oils and solvents
- Resistant to corrosion
- Blowout resistant

**Applications:**

- Aircraft engine and APU Gaskets
- Aerospace anti-ice systems and high temperature applications such as vanes
- Chemical processing
- In high thermal and mechanical loads, as well as when loads frequently change
- Diesel engines
- Saturated steam, superheated steam, heat carrier oils

\*Approvals applied for but not yet received.

\*\*Kevlar® is a trademark registered by DuPont

HiMod<sup>®</sup> FlatSeal<sup>™</sup> 36**Elements:**

Expanded graphite (purity >99.5%), expanded and flat metal inserts made from acid-proof stainless steel. Contains no bonding or filling agents

**Color:** Graphite gray

**Features and benefits:**

- Unique material profile for the maximum safety requirements
- Metal insert guarantees easy handling before installation and a strong performance in the flange
- Operating temperatures from -240°C to +550°C / -400°F to +1,022°F
- Withstands extreme pressure up to 250 bar / 2,175 psi
- Maximum thermal and mechanical stresses possible, even under changing loads
- Compatible with practically all organic and inorganic acids, alkalis, oils and solvents
- Resistant to corrosion (expanded and flat stainless steel inserts, AISI 316L / 1.4404)
- Fire safe approved (DIN EN ISO 10497 / AP1607 / BS6755)
- Leakage less than limits specified in DIN 3535-6
- Blowout resistant
- Complies to fugitive emissions standards with or without an inner eyelet

**Applications:**

- Aircraft engine and APU Gaskets
- Aerospace anti-ice systems and high temperature applications such as vanes
- Can be used universally in a wide variety of areas in the chemical and processing industries including in pipe flanges, apparatuses, pumps, heat exchangers and fittings

**Approvals:**

TA Luft\*, Fire safe, BAM\*, DVGW

HiMod<sup>®</sup> FlatSeal<sup>™</sup> 43**Elements:**

Modified and structured polytetrafluoroethylene (PTFE), filled with silica

**Color:** Beige

**Features and benefits:**

- Suitable for food contact; compliant with FDA 177.1550
- Operating temperatures from -210°C to +260°C / -346°F to + 500°F
- Compatible with a wide range of media including oils, greases, acids, alkalis, solvents, refrigerants, water and steam
- Compatible with concentrated mineral acids
- Excellent creep resistance
- High mechanical properties, withstands pressure to 83 bar
- Leakage below limits specified in DIN 3535-6
- Blowout resistant
- Complies to fugitive emissions standards
- Improved performance compared to conventional PTFE flat gaskets
- Unlimited shelf life

**Applications:**

- Aerospace industries
- Food, beverage and pharmaceuticals
- Petrochemicals
- Chemical processing
- Paper manufacturing

**Approvals:**

DVGW, BAM\*, TA Luft, FDA



# 45



HiMod® FlatSeal™ 45

**Elements:**

Multi-directional expanded polytetrafluoroethylene (PTFE)

**Color:** White

**Features and benefits:**

- Suitable for food contact; compliant with FDA 177.1550
- Operating temperatures from -210°C to +260°C/ -346°F to + 500°F
- Compatible with a wide range of media including oils, greases, acids, alkalis, solvents, refrigerants, water and steam
- Compatible with most lyes and acids throughout pH levels (pH 0-14)
- Excellent creep resistance
- Resistant to cold flow
- Good mechanical properties, withstands vacuum to 100 bar
- Leakage less than limits specified in DIN 3535-6
- Blowout resistant
- Complies to fugitive emissions standards
- Improved performance compared to conventional PTFE flat gaskets
- Unlimited shelf life

**Applications:**

- Food, beverage and pharmaceuticals
- Chemical processing
- Especially suitable for glass lined flanges and FRP equipment or in reactors

**Approvals:**

TA Luft, FDA

**TA Luft – German clean air act applying to flange systems**

Technical Instructions on Air Quality Control or Technische Anleitung zur Reinhaltung der Luft, is commonly referred to as the TA Luft. This is Germany's air pollution control regulation, parts of which have been adopted by other countries.

**A high-tech partnership**

The new HiMod® FlatSeal™ range of best-in-class flat gaskets is the result of a global strategic partnership entered into by Trelleborg Sealing Solutions and Frenzelit Werke. This will combine the expertise of both companies so that they can satisfy the needs of the market for high-quality flat gaskets.

Frenzelit brings its knowledge of gasket materials technology to the partnership, while Trelleborg contributes its expertise in providing solutions for challenging applications and has invested in leading-edge cutting facilities. Trelleborg also offers the benefit of a global support and sales network through which the two companies can develop business with industrial and aerospace customers.

Initially the HiMod® FlatSeal™ will be supplied into France, Germany, Italy, Spain and the UK.

**About Frenzelit**

Frenzelit Werke GmbH employs around 450 people worldwide. It has two manufacturing plants in Germany located in Bad Berneck and Himmelkron, with subsidiaries in North America and Asia. In addition to gaskets, the company's products include technical textiles, expansion joints and insulation materials.

\*Approvals applied for but not yet received.

## O-Ring Calculator and CAD Service now available on CD

The latest versions of our online tools O-Ring Calculator and CAD Service are now also available on CD for use offline. Order your copy from your local Trelleborg Sealing Solutions marketing company. Go to:

**NEW!**

- O-Ring Calculator:**  
- Latest update now live
- CAD Service:**  
- Fully updated  
- New products added



upd



## Mechanical Face Seal E-Shop

### Order online and benefit from:

- Choose from a selection of Mechanical Face Seals made from roller bearing steel and Nitrile Butadiene Rubber (NBR)
- Open 24/7
- Quick and easy seal selection by size, cross references of equipment manufacturers and seal suppliers or seal dimensions
- Express delivery, usually within two to three working days within Europe, within five to six working days for all other regions
- Convenient payment by credit card
- Technical advice and help with seal selection via telephone hotline or email

**Check out the latest offers**



## Sealing Solutions Configurator: Revolutionizing the way we work

**NEW!**

Now available in German  
Approvals search added  
Better user interface

**Trelleborg's Sealing Solutions Configurator is a unique online tool. It allows engineers to identify a proven sealing solution for a specific application.**

### 4 Easy steps to solving your sealing problems:

#### Step 1:

##### Select your Equipment

First select your industry and market segment - then the type of equipment or machinery the sealing solution is required for.

#### Step 3:

##### Enter your operating parameters

Now specify the operating parameters of your application.

#### Step 2:

##### Select your Application

Next select the type of application you are working on.

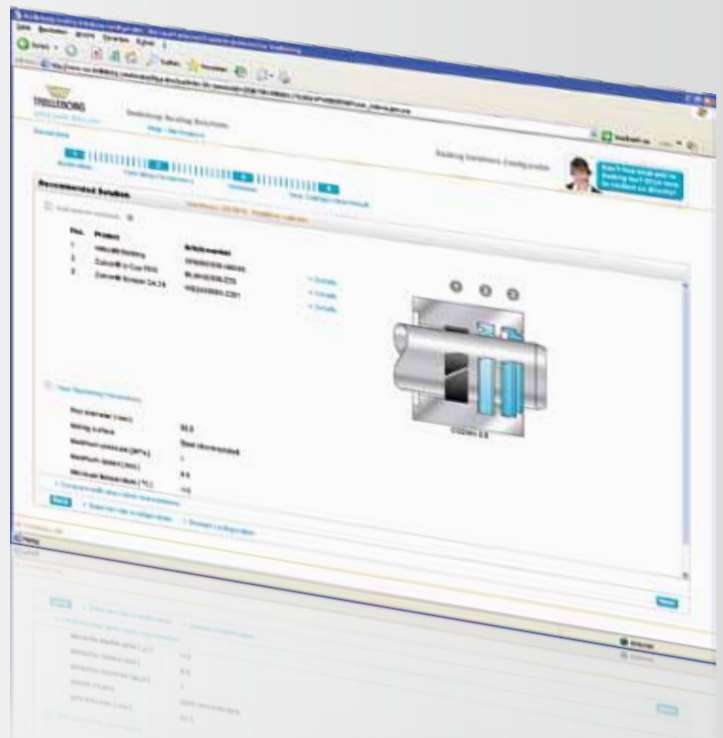
#### Step 4:

##### Get your sealing solution!

Save the project and in just a few seconds you will receive a recommendation for a proven solution from Trelleborg Sealing Solutions!

# E-tools ate

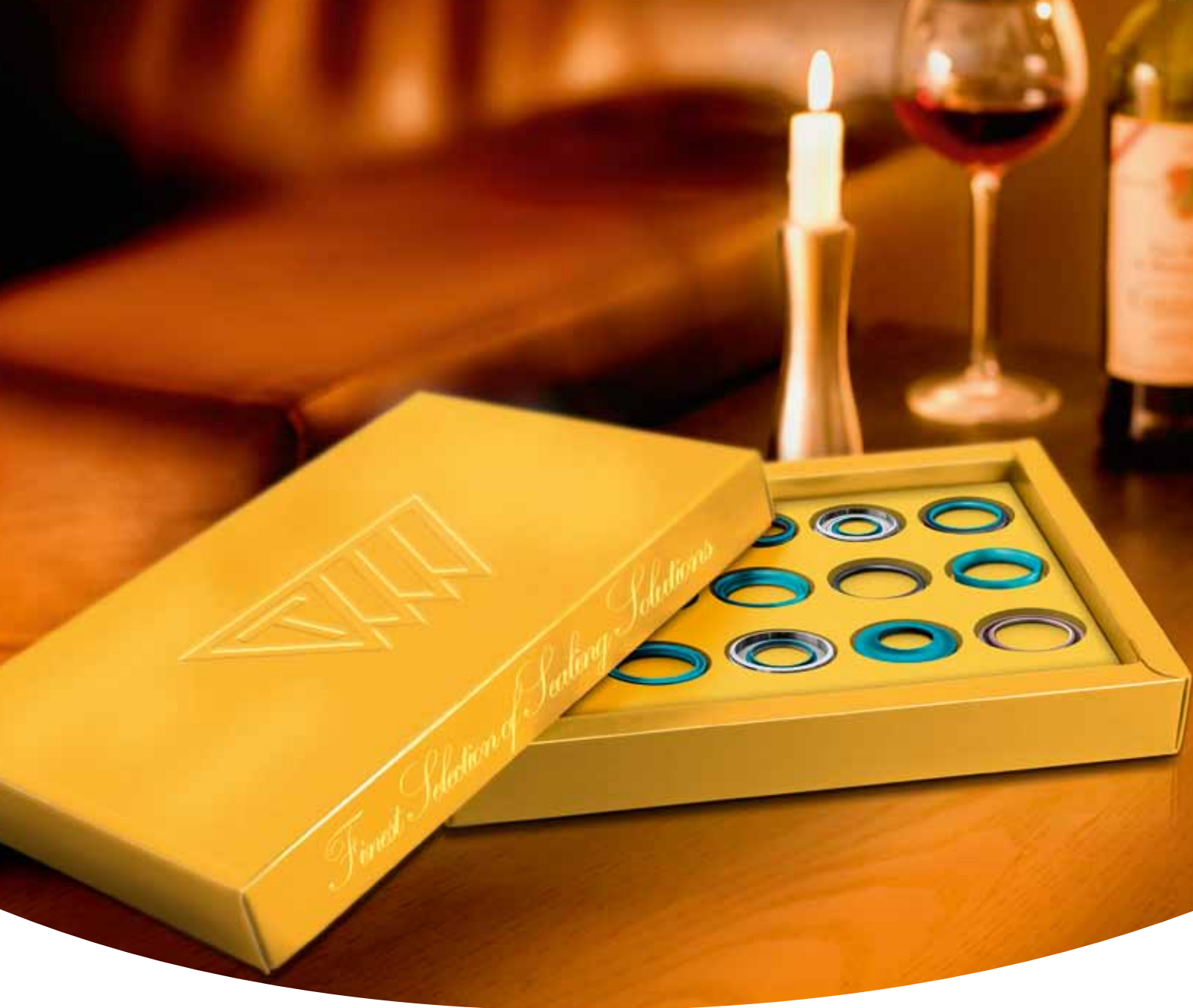
At Trelleborg Sealing Solutions we are continually working to make our e-tools better and easier to use. See what's been going on over the past few months!



### Storing, quotes and advice

Once a project is stored the user gets access to additional services through the tool, such as downloading the corresponding CAD drawing of items recommended, creating a PDF of the configuration result, sending a request for a quotation or request for advice.

Requests for advice will be picked up by technical experts in the user's local Trelleborg Sealing Solutions marketing company who will contact the user and assist in the development of their sealing solution. This tool facilitates easy discussion of the project, as all parameters are visible to both the customer and the Trelleborg Sealing Solutions technical expert, online.



## A complete selection of the finest seals...

**available from Trelleborg Sealing Solutions – your one-stop-shop.**

Trelleborg Sealing Solutions offers an outstandingly comprehensive sealing portfolio – a one-stop-shop providing the best in elastomer, thermoplastic, PTFE and composite technologies; our solutions are featured in virtually every application conceivable within the aerospace, automotive and industrial industries.

Your Partner for Sealing Technology

Trelleborg Sealing Solutions

[www.tss.trelleborg.com](http://www.tss.trelleborg.com)



  
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SEALING SOLUTIONS