

Sealing Solutions for Robotic Applications



Your Partner for Sealing Technology

Trelleborg Sealing Solutions delivers better performance and overall profitability through the use of pioneering techniques. Our innovation is key to your success.

Round-the-clock operations and
international logistics

designed to meet scheduling requirements

Global engineering

resources provide the right solution for any sealing application

Extensive
sealing expertise

accelerates the time to market, improves efficiency of existing applications and lengthens maintenance intervals

LEADING SEALING SOLUTION PROVIDER

Trelleborg Sealing Solutions is a leading global supplier of high quality seals, bearings and components, offering 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 segments, including robotics.

As a rapidly evolving industry, robotics is led by constantly innovating technologies, and at Trelleborg our philosophy is the same. We can support you in providing a solution for your application needs. Product reliability and customer focus are paramount.

MANUFACTURING CAPABILITIES

Uniquely placed to offer dedicated design and development, Trelleborg Sealing Solutions globally serves, supports and supplies customers through an unrivalled international network.

- Over 80 facilities worldwide
- More than 20 manufacturing sites
- Nine strategically positioned materials and development laboratories
- Internationally linked design and application centers
- Global manufacturing capabilities allow us to produce sealing solutions to the same specification and quality standards worldwide



Interactive brochure
Scan the AR icon with your smartphone to connect with us!



- 9 R&D Centers
- 53 Marketing Companies
- 4 Logistics Centers
- 28 Manufacturing Sites
- Damping Solutions
- 5 Automotive Hubs
- 9 Aerospace Hubs

EXPERIENCE AUGMENTED REALITY



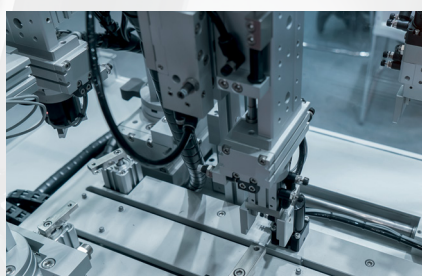
To fully experience this augmented reality brochure, scan the QR code to download the app from the App Store or Google Play, or download directly by searching for "Trelleborg Sealing Solutions Augmented Reality Library".

- 1 Install and start the app on your device.
- 2 Use your device to scan the AR symbol wherever you find it in the brochure to see films, animations and other interactive features.



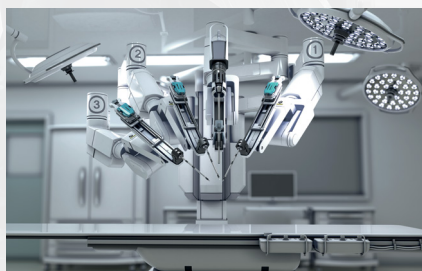
Applications by Industry

Trelleborg Sealing Solutions supports the modern and rapidly evolving robotics industry through its engineering resources, materials expertise and local support.



INDUSTRIAL ROBOTICS

Trelleborg Sealing Solutions is a long-standing expert in industrial robotics, supplying complex sealing configurations for rotary components and linear applications. The main types are articulated robots, cartesian robots, parallel-link (delta robots), SCARA robots and AGVs (Automated Guided Vehicles).



MEDICAL / SURGICAL / HEALTHCARE ROBOTICS AND POWERED EXOSKELETONS

Trelleborg Sealing Solutions utilizes its wide range of sealing materials, global R&D network and years of experience in healthcare to meet challenging robotics requirements.



CONSTRUCTION / DISASTER RECOVERY / PROBE ROBOTICS

Trelleborg Sealing Solutions is a leading supplier of advanced sealing solutions for robotics used in areas where humans can't enter easily due to disasters, deep waters or limited spaces. Trelleborg's solutions support accurate movement, are compatible with aggressive media and withstand extreme temperatures.



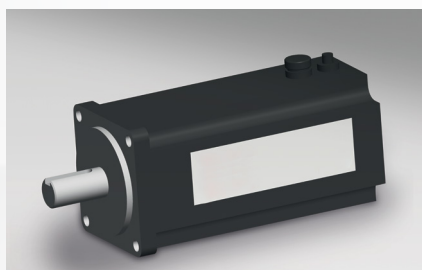
SURVEILLANCE / HOUSEHOLD / ENTERTAINMENT ROBOTICS

Trelleborg helps improve performance or manufacturing efficiency by providing unique, custom-engineered solutions – suited to individual needs. This may be a flat gasket of any dimension, a rubber-to-metal element or a LSR component with complex geometry that can consolidate a number of products into one.



DRONES / PERSONAL MOBILITY ROBOTICS

Trelleborg Sealing Solutions is capable of contributing to advances in these intelligent markets based on a comprehensive portfolio of products and materials, and over 60 years of experience providing solutions to numerous industries.



ROBOTICS-RELATED COMPONENTS

Trelleborg Sealing Solutions provides components, manufactured with our innovative materials and engineering, as vital parts to improve performance and efficiency in robotics applications.

Where Our Solutions Are Found

Robotics components must support the unit in its daily operations, maintaining performance and reducing downtime. See some examples of how our products contribute to efficiency and reliability in robotics applications.



CASE STORY: TURCON® VARILIP® PDR

Trelleborg Sealing Solutions was approached to recommend a solution to ensure that the motor brake for a robotics application had a reliable Back-up seal for a Radial Oil Seal. Should the Radial Oil Seal fail, the oil should be retained for 100 hours without leakage.

Operating Requirements:

- Oscillating speeds up to 1,800 RPM (5,000 max)
- Dry-running and lubricated performance
- High volume production
- Temperature range: -20 °C to +130 °C / -4 °F to +266 °F

Trelleborg's Solutions:

The seal chosen was a Turcon® Varilip® PDR with a cased, single-element design. An engineered sealing lip featured concentric slits and an extra light lip load, manufactured from PTFE. This satisfied all the operating requirements and enabled high volume, cost-effective production. Testing proved over 8,000 hours of effective dry-running time and an additional 100 hours with oil.



Upper Arm Unit and Wrist Unit

Application Requirements:

- Smooth oscillation (low friction) with good sealing performance
- Reduce wear on mating surface of seal
- Compact design

Trelleborg's Solutions:

Wide range of rotary seals in different high performance materials, such as Radial Oil Seals, Turcon® Variseal, Forsheda® V-Ring® and Engineered Molded Parts.

Drive Motor Unit and Reduction Gear

Application Requirements:

- Operation with high input shaft speed
- Low friction with good sealing performance
- Compact design (thin seal width)

Trelleborg's Solutions:

Elastomer-based and PTFE lip shaft seals for drive motors and reduction gear units that are subject to high input shaft speeds.



Drive Motor Unit

Application Requirements:

- Operation with high input shaft speed
- Low friction with good sealing performance
- Compact design (thin seal width)

Trelleborg's Solutions:

Rotary shaft seals and PTFE lip rotary shaft seals allow for lower friction, heat generation, and robust sealing solutions.

Gearbox Cover

Application Requirements:

- Reduction of parts
- Elimination of contamination associated with groove voids
- Tolerance against lower quality mating surfaces

Trelleborg's Solutions:

Bonded Seals, Rubore® Seals, 2K LSR products and Engineered Molded Parts can be used as gearbox lids to protect vital components.

Gas Balancer

Application Requirements:

- Low friction with good sealing performance
- Compact design

Trelleborg's Solutions:

A new Zurcon® polyurethane U-Cup with good abrasion resistance, low compression set, high extrusion resistance and a wide operating temperature range.

Base Unit

Application Requirements:

- Good chemical compatibilities to prevent corrosion of the shaft
- Low friction with good sealing performance
- Compact design

Trelleborg's Solutions:

A wide range of rotary seal products and a unique shaft repair kit to maintain rotary shaft lip seals without replacing the shaft.

OUR SOLUTIONS FOR PARALLEL-LINK ROBOTS

Top Cover Lid

Application Requirements:

- Easy assembly
- Reduction of attachment quantity
- Secure robot horizontally

Trelleborg's Solutions:

A wide range of rubber-to-metal bonded seals and various rubber gaskets.

Parallel Arm Unit

Application Requirements:

- Smooth movement
- Low wear
- Dry running

Trelleborg's Solutions:

Bearings from Orkot® materials, which are a range of thermoset composite bearing materials consisting of technical fabrics impregnated with thermosetting resin. Customer-specific elastomer molded products and FDA-compliant materials are also available.

Gearbox Installation Part

Application Requirements:

- Compact design
- Easy assembly
- Low friction with good sealing performance

Trelleborg's Solutions:

Choice of a variety of static seal products, from elastomer O-Rings to rubber-to-metal bonded seals to meet customer-specific requirements.

Under Cover

Application Requirements:

- Low friction with good sealing performance
- Low heat generation
- Compact design

Trelleborg's Solutions:

A selection of dust seals and scrapers to meet customer-specific requirements.

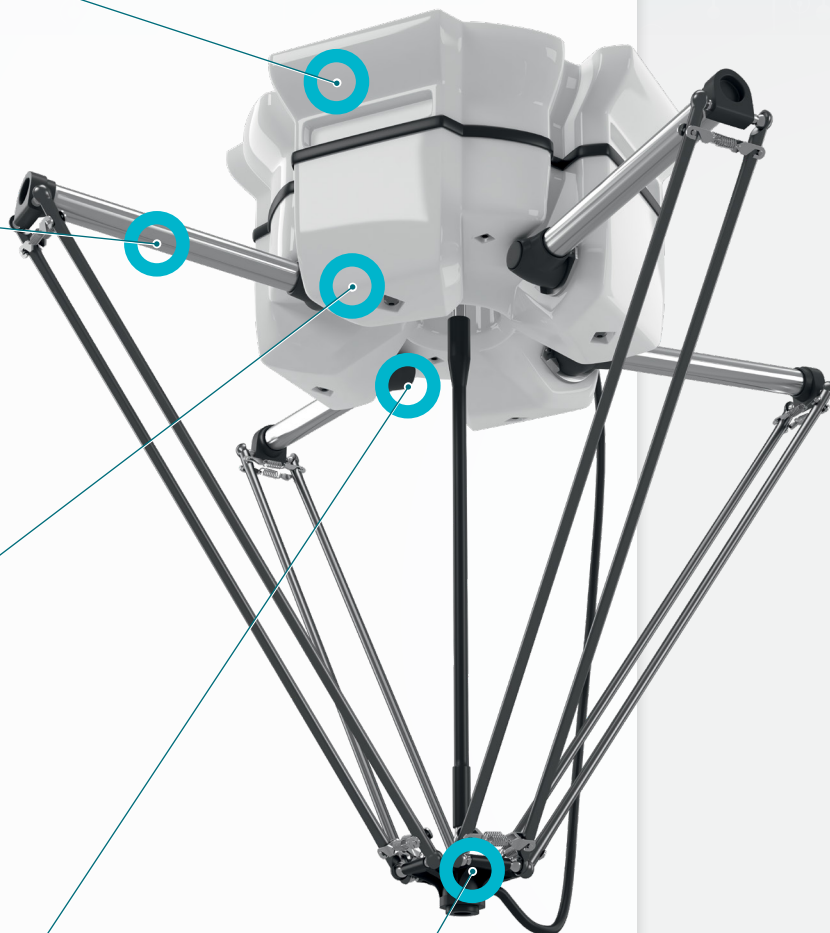
Movable Plate Unit

Application Requirements:

- Compact design with low weight
- High speed operation
- Low friction with good sealing performance

Trelleborg's Solutions:

Wide range of rotary seals to prevent the ingress of foreign particles, such as dust, water and chemicals.



OUR SOLUTIONS FOR SCARA ROBOTS

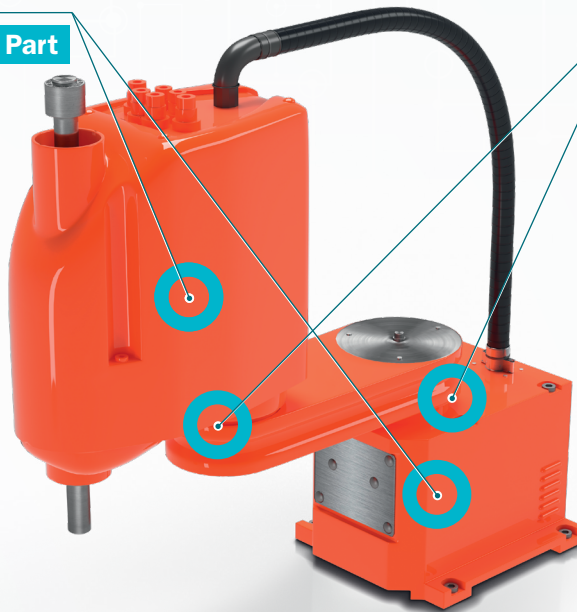
Motor/Reducer Installation Part

Application Requirements:

- Compact design
- Easy assembly
- Low friction with good sealing performance

Trelleborg's Solutions:

High performance static seals, from elastomer O-Rings to rubber-to-metal bonded seals that meet customer-specific requirements.



Axis 1 & 2

Application Requirements:

- Chemical compatibility
- Compact design
- Low friction with good sealing performance

Trelleborg's Solutions:

Wide range of rotary seals, from rubber Radial Oil Seals to PTFE-based rotary seals, to meet customer requirements.

OUR SOLUTIONS FOR CARTESIAN ROBOTS

Vertical and Horizontal Motion Unit

Application Requirements:

- High speed
- Compact design
- Low friction with good sealing performance

Trelleborg's Solutions:

A specially designed low friction pneumatic seal comprising a slipper seal and an energizing O-Ring with smaller installation size requirement.

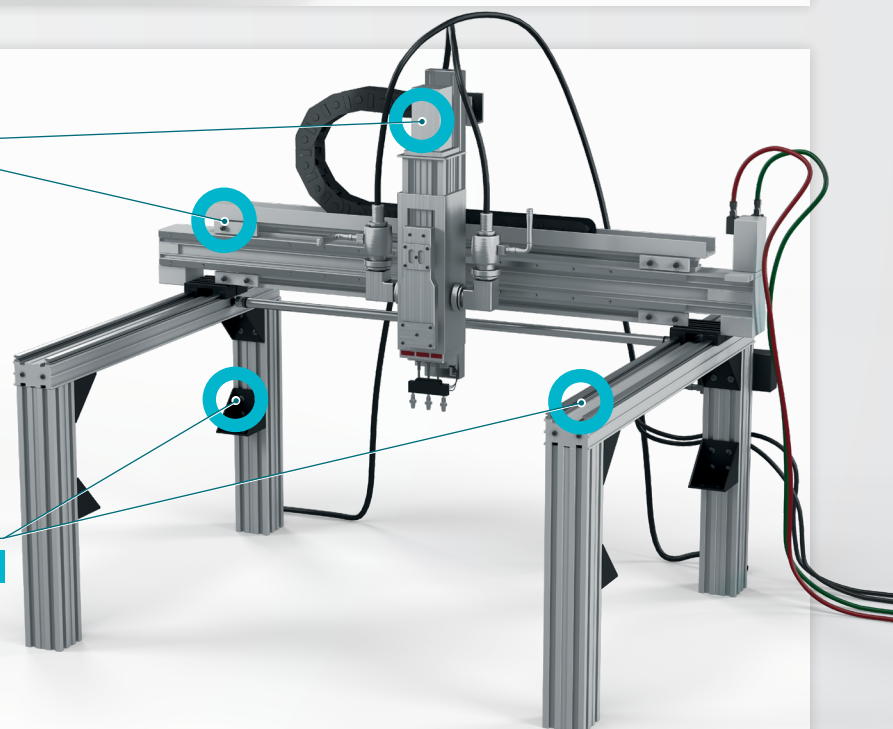
Postural Adjustment Unit and Anti Drop Unit

Application Requirements:

- Compact design
- Low friction with good sealing performance
- Accurate movement and positioning

Trelleborg's Solutions:

A selection of pneumatic and dust seals, manufactured from elastomer-based materials, Zurcon® high-performance polyurethane and Turcon® PTFE materials.



Product Spotlights



Trelleborg offers one of the most extensive ranges of pneumatic, hydraulic, rotary seals and rubber-to-metal gaskets to match the sealing requirements of robotic applications.

BEARINGS & BUSHINGS

Trelleborg Sealing Solutions is an expert, not just in seals, but in bearings too. In many cases, the use of plastics as the primary bearing material can give distinct advantages.

Plastics offer the user design flexibility and superior performance capabilities, such as lighter weight components, noise reduction and lubrication-free use.



ORKOT® BEARINGS

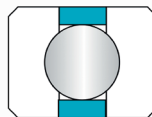
Orkot® is a composite consisting of technical fabrics impregnated with thermosetting resins, evenly dispersed solid lubricants and other additives. Orkot® bearings offer significant advantages over traditional metal bearings

- Self lubricating, environmentally-friendly
- Bespoke sizes and designs possible to optimize performance
- High load capacity and resistant against shocks and vibration
- Dry operation or lubricated to suit any robotic application
- Low friction and excellent wear resistance to provide smooth operation between extended maintenance intervals



DUROBAL®

Durobal® bearings are used in a variety of devices and equipment where conventional metal bearings can not be used. The inner and outer rings provide support against the mating hardware, while the cage maintains ball separation.



- Self-lubricating, environmentally-friendly
- Low-friction
- Molded to consolidate component parts
- Materials compatible with virtually all media, both system and cleaning
- Light-weight with good strength and stiffness



HIMOD® SLYDRING®

HiMod® SLYDRING® are made from special, modified thermoplastic material for hydraulic cylinders with medium to high loads.

HiMod® HM0610: A special glass fiber reinforced polyacetal.

- Velocity, reciprocating: Max. 0.8 m/s
- Temperature: -40 °C to +110 °C
- Radial SLYDRING® pressure: Max. 40 N/mm² at 25 °C and max. 25 N/mm² at >60 °C

HiMod® HM062: A special glass fiber reinforced heat-stabilized polyamide with PTFE filler.

- Velocity, reciprocating: Max. 1.0 m/s
- Temperature: -40 °C to +130 °C
- Radial SLYDRING® pressure: Max. 75 N/mm² at 60 °C and max. 25 N/mm² >60 °C



ORKOT® SLYDRING®

Orkot® SLYDRING® are wear rings manufactured from tubular or strip composite material. They cover a temperature range from cryogenic to +250 °C in a wide range of media to suit most robotic applications.

- High load bearing capacity
- Eliminates local stress concentrations
- Wear-resistant, long service life
- Favorable friction behavior
- Damping of mechanical vibrations
- Good wiping effect, embedding of foreign particles possible
- Simple groove design, easy installation

ROTARY SEALS

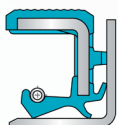
Rotary seals are used in components with oscillating or rotating parts to keep lubrication fluids in place while preventing the ingress of contaminants. Trelleborg Sealing Solutions

components are proven to improve the life and long-term performance of your application, demonstrating superior low-friction properties and excellent resistance to wear.



APJ-CASSETTE SEAL

- All the advantages of Rotary Oil Seals, plus the integration of a fine machined stainless steel, pre-lubricated sleeve
- Provides a fully encapsulated sealing system
- Does not require hardening of the shaft or grinding
- Replacement is easy and fast as the shaft is not worn down by the sealing lip
- FDA-compliant elastomers and greases



FORSHEDA® V-RING®

- Frictional losses and heat kept to a minimum
- Low contact pressure allows dry running in many applications
- Excellent wear characteristics
- Can perform even with certain amounts of run out, eccentricity and shaft misalignment
- Can be installed over various other components without dismantling



ROTARY OIL SEAL

- High resistance to wear from tailored materials and design
- Low friction and compression set
- Fluoropolymers available for compatibility with synthetic oils
- FDA-compliant material available
- Single or double dust lip, according to contamination level and type



SPECIAL ROTARY OIL SEAL

- The advantages of Rotary Oil Seals and V-Rings® are both combined in this special design
- Design and materials optimized for robotic motion, offering low torque and low wear
- Design of the axial excluder lip can be tailored according to rotating speed and axial play



HYBRID ROTARY OIL SEAL

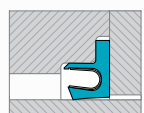
- The advantages of elastomeric Rotary Oil Seals and a Turcon® excluder are combined in this special design
- The tailored elastomeric seal provides the best oil sealing capability, being optimized for

- robotic motion and able to withstand pressure with high eccentricity and vibrations
- The Turcon® lip acts as a backup excluder against ingress of any sort of chemical aggressive contaminants



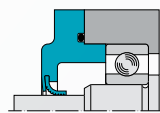
TURCON® ROTO VARISEAL®

- Highly abrasion resistant PTFE grades utilizing Trelleborg's material compounding expertise
- Compatible with virtually all fluids, chemicals and gases
- Suitable for reciprocating and rotary applications
- Long service life, good scraping ability even with high viscosity media
- FDA-compliant grades available



TURCON® VARILIP® PDR ROTARY SHAFT SEAL

- Highly abrasion resistant PTFE grades utilizing Trelleborg's material compounding expertise
- Low friction designs with excellent fluid compatibility characteristics and dry running capabilities
- Suitable for high speed shaft applications (up to 100m/s in service)
- FDA-compliant grades available
- Multiple lip designs available to suit application and contamination levels
- Conductive PTFE grades available to provide electrical discharge



PNEUMATIC SEALS

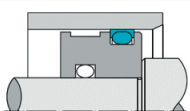
Pneumatic seals operate in dynamic applications, often at high speeds, generally with reciprocating motions. Trelleborg Sealing Solutions supplies a number of seals, wear rings and scrapers / wipers specifically engineered for pneumatic

applications, where cylinders and valves are actuated by air. In addition, where a standard product type is not suitable, custom solutions can be developed.



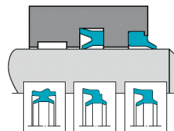
GLYD RING® FOR PISTONS AND RODS

- Low stick-slip
- High speed performance
- Wide range of application temperatures
- Available for all rod diameters up to 2700 mm



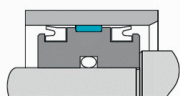
ROD SEAL AND ROD SEAL - SCRAPER COMBINATION

Pneumatic rod seals are available as lip seals and rod seal/scraper combinations for closed and open housings. Special materials provide high abrasion resistance and low friction cost-effectively. They are recommended for applications in standard cylinders, installed with a separate scraper or as rod seal/scraper combination for dry air.



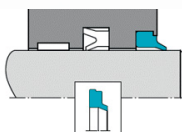
WEAR RING FOR PISTONS AND RODS

- Good price/performance ratio
- High compressive strength
- Very good sliding effect in dry conditions
- Good resistance to abrasion
- Low stick-slip effect
- Simple installation in closed grooves
- Long life



SCRAPER / SCRAPER FOR GUIDING UNITS

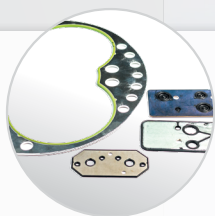
- Excellent chemical resistance
- Outstanding resistance to heat and low temperature
- Good resistance to ozone and weathering
- High resistance to wear
- Low friction and compression set
- Highly elastic



ENGINEERED MOLDED PARTS

Trelleborg Sealing Solutions offers one of the broadest ranges of sealing elements on the market. Most of the time, the tried and tested method works, but sometimes a unique application requires a unique solution. Our team of engineers will support you in the development of a customized engineered molded

part designed to suit your individual needs. This may be a flat gasket of any dimension, a rubber-to-metal element or a seal of complex geometry that may consolidate a number of products into one.



RUBBER-TO-METAL BONDED SEALS

Embedding the seals in a metal plate eliminates the need for making grooves in the counterparts, reducing the complexity of the manufacturing process and associated costs.

Combining several seals into one sealing plate offers several benefits:

- Easy to assemble
- Single sealing component reduces complexity
- Risk of misassembly eliminated, as all seals held in single, visible plate



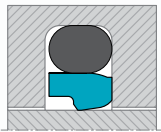
APPLICATION DESIGN ENGINEERING AND ELASTOMERS COMPOUNDING

- Size range: 20mm – 2400 x 900mm
- Thickness: 0.6mm – 10mm
- Compounds: HNBR, FKM, NBR, EPDM, CR, NR, VMQ, ACM & AEM
- Materials: Aluminium, Steel, Stainless steel, Engineered plastics
- Plating/Coating: Corrosion protective plating on steel available, as well as MaxWax® assembly wax treatment

HYDRAULIC SEALS

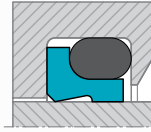
It is challenging to ensure seal life and performance in hydraulic applications. Not only must leak-free operation be achieved, but high pressures, temperatures and transverse forces must be sustained. Highlighted here are four of the most important

seals for gas balancers or hydraulic applications within Industrial Articulated Robots and Disaster recovery / Probe robots.



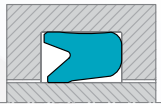
TURCON® STEPSEAL® 2K

- High static and dynamic sealing effect
- High extrusion resistance meets high hardware clearances
- Low friction, high efficiency
- Stick-slip free
- High abrasion resistance and operational reliability
- Wide range of application temperatures and good resistance to chemicals
- Available for all rod diameters up to 2600 mm



TURCON® EXCLUDER 2/5

- Outstanding sliding properties
- Stick-slip free
- Can follow deflections of the piston, rod or plunger
- Space-saving construction
- Very good scraping effect against external contaminants, even with firmly adhered dirt, etc.
- Excellent scraping effect from the inside against the residual oil film adhering to the surface of the piston rod
- Good resistance to hydraulic media



ZURCON® U-CUP RU9

- High extrusion resistance
- Excellent dynamic and static sealing
- Optimum environmental protection
- Back-pumping ability over the entire pressure range achieved by grooved profile
- Can be used as a secondary seal in combination with the Zurcon® Buffer Seal
- Suitable for sealing systems with double-acting scrapers



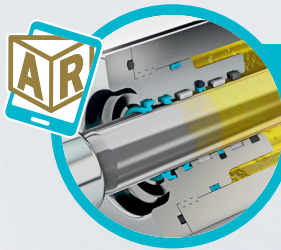
ZURCON® SCRAPER ASW

- Simple groove design
- Very good scraping effect, wear resistant
- No tilting or twisting in the groove
- Simple installation
- Flush fitting with outer surface



Unrivalled Capabilities

Trelleborg Sealing Solutions contributes more benefits than a simple seal supplier. Engineering, design and development teams work with customers across the globe to help them achieve their goals, whether starting from a 'black box' specification, or aiding testing and qualification to get a product to market.



LUBRICATION MANAGEMENT

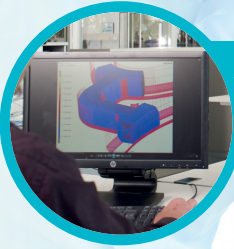
- Optimized performance
- Improved friction characteristics
- Extended system life



MANUFACTURING & MATERIAL DEVELOPMENT

State-of-the-art development laboratories and manufacturing techniques lead to products with:

- Enhanced chemical compatibility
- Expanded temperature capability
- Reduced weight



PROJECT MANAGEMENT & QUALIFICATION

Full service project management from development to serial production and product introduction



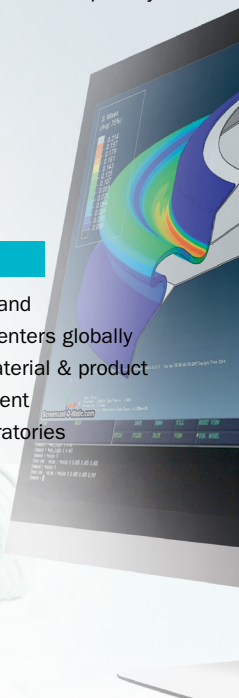
ENGINEERING

- Modern CAD tools (CATIA V)
- Experienced designers
- On-site design at customer facilities
- Dedicated project management
- FEA modeling
- Prototyping
- Custom-made solutions



TESTING

- Nine research and development centers globally
- World class material & product testing equipment
- Analytical laboratories



MATERIAL EXPERTISE

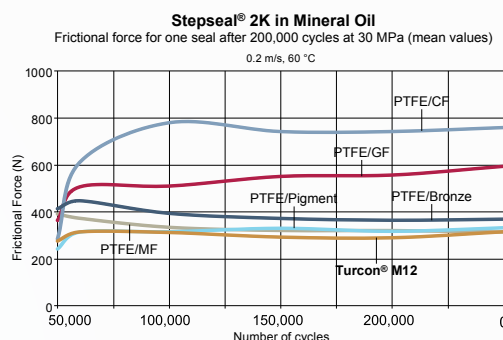
Trelleborg Sealing Solutions has developed an industry leading group of materials within each material type. Robotics manufacturers can select the compound that best suits their needs.

TURCON®

Outstanding friction characteristics

Turcon® is the brand name of the Trelleborg Sealing Solutions range of proprietary materials based on premium-grade Polytetrafluoroethylene (PTFE). The materials demonstrate low friction, with minimized wear in dynamic and even high speed applications. They are compatible with virtually all media, even at elevated temperatures, and are resistant to aging.

Turcon® M12, is a cost-effective material that provides customers with extended seal life, as well as a wide operating window in terms of temperature, pressure and velocity. It performs as well or better than other specialized compounds in each parameter.



ADVANCED ELASTOMER MATERIALS

NBR (Nitrile Butadiene Rubber)

NBR is primarily used with mineral-based oils and greases, providing in general the material has good mechanical operating temperatures.

HNBR (Hydrogenated Nitrile Butadiene Rubber)

HNBR is often used in high-temperature applications due to its excellent abrasion resistance and mechanical properties.

FKM (Fluoroelastomer)

FKM is known for its non-flammability, low gas permeability and excellent resistance to ozone, weathering and aging. Suitably formulated FKM can be used down to -35 °C / -31 °F and meets requirements for mineral based oils and greases at high temperatures.

VMQ (Silicon Rubber)

VMQ has very good heat resistance, low temperature flexibility and electrical properties, and excellent resistance to weather, ozone and UV rays. Specific VMQ formulations are resistant to aliphatic engine and gear box oils, water up to +100 °C / +212 °F and high molecular chlorinated hydrocarbons (e.g. Chlophen).

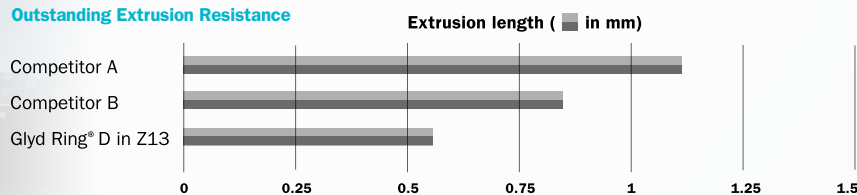
ZURCON®

Zurcon® engineered polyurethane-based materials exhibit outstanding friction characteristics. The newly developed Zurcon® Z13 material is specially developed to cope with pressures up to 50 MPa / 7,250 psi at both sides of the seal and at temperatures up to +120 °C / +248 °F.

Chemical Compatibility

Fluid Type	DIN / ISO code	Temperature		Results
Mineral Oils	HLP/HVLP/HLPD	+110 °C	+230 °F	Excellent
Synthetic fluids	HEES	+80 °C to +100 °C	+176 °F to +212 °F	Excellent
	HEPG (PAG)	+60 °C	+140 °F	Good
	HEPR (PAO)	+100 °C	+212 °F	Excellent
Water-based fluids	HFA	+50 °C to +60 °C	+122 °F to +140 °F	Good
	HFC	+60 °C	+140 °F	Excellent
Synthetic water-free fluids	HFDU	+100 °C	+212 °F	Excellent

Outstanding Extrusion Resistance



Trelleborg is a world leader in engineered polymer solutions that seal, damp and protect critical applications in demanding environments. Its innovative solutions accelerate performance for customers in a sustainable way.

Trelleborg Sealing Solutions is a leading developer, manufacturer and supplier of precision seals, bearings and custom-molded polymer components. It focuses on meeting the most demanding needs of aerospace, automotive and general industrial customers with innovative solutions.

WWW.TSS.TRELLEBORG.COM



facebook.com/TrelleborgSealingSolutions
twitter.com/TrelleborgSeals
youtube.com/TrelleborgSeals
linkedin.com/company/trelleborg-sealing-solutions

If you'd like to talk to Trelleborg Sealing Solutions, find your local contact at: www.tss.trelleborg.com/worldwide