Parker Prädifa

ENGINEERING YOUR SUCCESS.

March 2013

SealingReport

Experience „Sealing Technology in 4D“

HANNOVER MESSE

8 - 12 April 2013
Hall 20 · Stand B20

Fluidpower

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SealingReport

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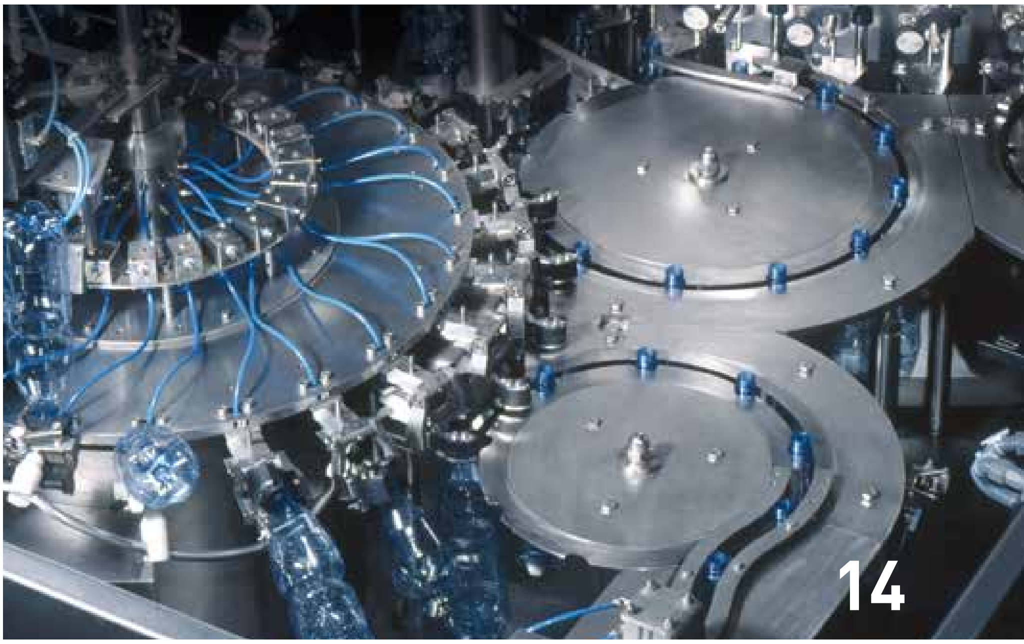


Welcome to the 2013 Hanover Fair

Dear customers

Welcome to our state-of-the-art technology stand. We cordially invite you to personally experience our latest developments in sealing technology. “Integrated Technology” is on everyone’s lips at the moment. We are going to show you how we are implementing this concept in sealing technology in a way that is both practical and in line with fair market prices – not least through joined-up thinking and close development partnerships with you, our customers. Visit us on our Stand B20 in Hall 20 and find out how:

- **In the field of fluid power** we can improve the efficiency of your equipment through intelligent, friction-optimised sealing systems, increase its service life and reliability by minimising dirt ingress or help you to save time and costs through simplified assembly.
- **In the field of pharmaceutical and food production** we put you on the safe side in hygienically sensitive applications with our CIP-/SIP-resistant sealing compounds and seal geometries that prevent bacterial growth.
- **In the field of electronics** efficient Form-in-Place gasket solutions allow you to manage the various shielding and sealing requirements in increasingly miniaturised multi-tasking devices in an equally low-cost and reliable way.
- **In the field of alternative drive concepts** our comprehensive range of new high-performance compounds successfully tackle the media challenge in modern vehicles – from AdBlue® to exhaust condensates through to hydrogen. And thus sustainably secure the required operational reliability, environmental friendliness and future viability of your products.
- **In the field of RFID technology** conventional O-Ring seals can become future “smart seals” and what potential they open up in such areas as inventory management and production.

At our TECH.FORUM you can experience “**Sealing Technology in 4D**“ this year. Come and see us and let yourself be surprised by the possibilities of advanced virtualization! Based on a wealth of concrete application examples we will be pleased to present and explain our “integrative” solutions to you. As usual, your points of contact from research, product development, engineering and sales will be available to meet with you on all five days of the fair. We look forward to your visit and many inspiring and informative discussions. Naturally, apart from the Hanover Fair, we are always ready to serve you as well, in keeping with our promise of

ENGINEERING YOUR SUCCESS.

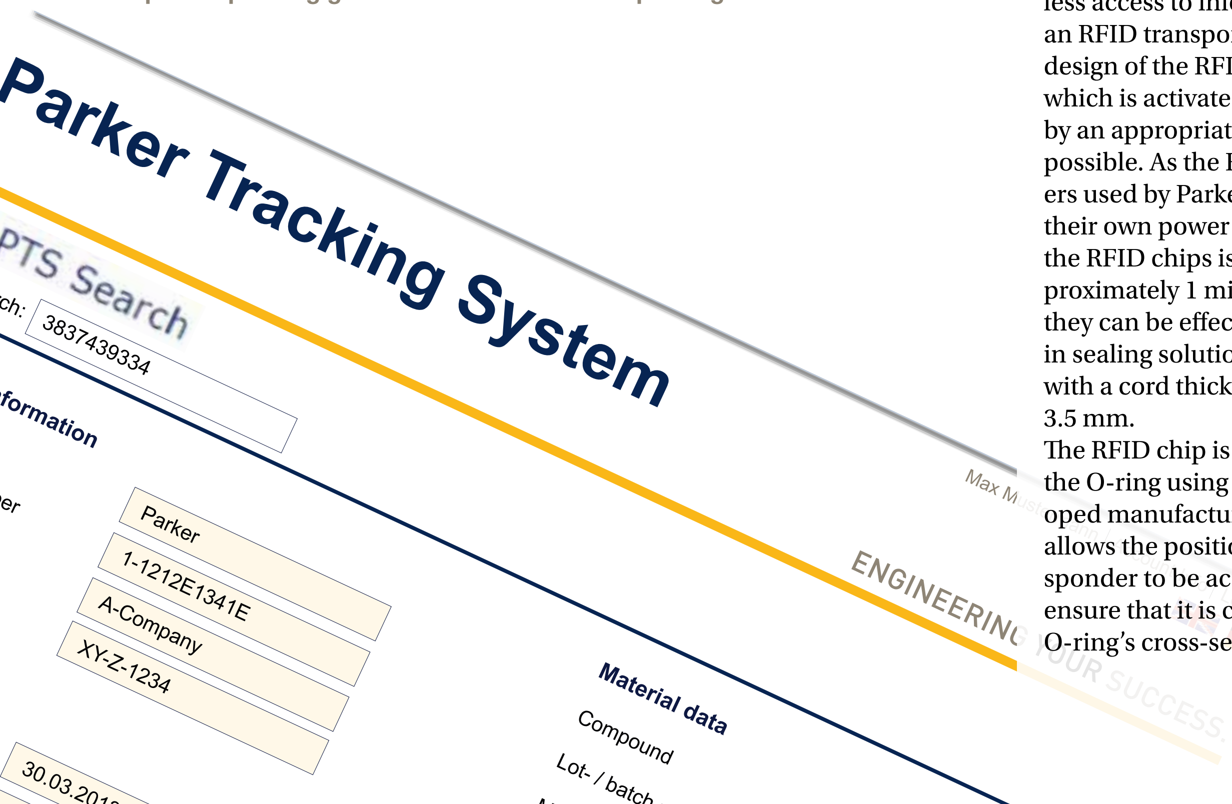
Jochen Nigge
General Sales Manager
Seal Group Europe

The O-ring as a storage medium

Major extension of the performance range of sealing solutions

Dr Heinz-Christian Rost
Technology & Innovation Manager
O-Ring Division Europe

Parker has managed to equip O-ring seals with RFID chips. The embedded RFID technology makes it possible to pursue totally new approaches to managing sealing solutions in the customer's operations. Definite identification, tracking, warehouse management, component assembly and equipment maintenance are just some of the areas in which the significant advantages of this new patent-pending generation of seals can be put to good use.



The fusion of easy to use storage technology and first-class sealing technology for static applications elevates the sealing solutions developed by Parker to a new performance level. RFID (= Radio Frequency Identification) technology allows contactless access to information stored on an RFID transponder. The special design of the RFID transponder which is activated and can be read by an appropriate reader makes this possible. As the RFID transponders used by Parker do not require their own power supply the size of the RFID chips is in the range of approximately 1 millimetre. As a result, they can be effectively implemented in sealing solutions such as O-rings with a cord thickness of more than 3.5 mm.
The RFID chip is vulcanised into the O-ring using a specially developed manufacturing process. It allows the position of the RFID transponder to be accurately checked to ensure that it is centred within the O-ring's cross-section. Parker has the

capability of embedding RFID technology in all standard sealing compounds. The O-rings thus equipped can be used in a wide range of media and temperatures.
The RFID chips are suitable for application-specific programming and can be read from a distance of several metres. The performance capability of the sealing element, such as compression set or behaviour in the application medium, is only influenced marginally, as laboratory tests have confirmed. To enable accurate identification of every single Parker O-ring equipped with an RFID transponder each RFID chip has a unique identification number. This identification number is read and can be linked with specific information via the Parker Tracking System.

Parker Tracking System links O-rings with information

The Parker Tracking System (PTS) is a web-based service that is made available to Parker's customers. It provides convenient access to the stored information which is linked to the O-rings with embedded RFID. Even the standard solution captures a wide range of product information. For clear identification of the O-rings, customer-, logistics- and material-specific information is included:

Customer information
- Supplier
- Supplier's part number
- Customer
- Customer's part number

Logistics
- Shipping date
- Date of receiving inspection

Material
- Compound
- Lot / batch number
- Manufacturing date
- Hardness
- Specific weight
- Tensile strength
- Modulus
- Ultimate elongation

The sealing system can be clearly identified and verified according to this basic information. A Parker O-ring shipment can thus be allocated to the subsequent logistics management process based on the part number, O-ring dimension and material data including the batch history right in the customer's receiving department without the risk of mix-ups. Every single seal with embedded RFID technology can be read and checked around the clock with-out the need for complex, paper-based documentation. The benefits for logistics management are obvious. The number of parts in stock, the time at which the sealing solution leaves the warehouse and its location in the process can be determined at any time.

During O-ring assembly the Parker RFID chips allow the worker to quickly and easily check if the right sealing solution is being installed in the right application. After installation in the application system the operator can verify, without requiring line of sight, that the seal has been installed – which marks a major step forwards in quality assurance.

Maintenance of complex equipment is significantly simplified

The possibility of easily reading the RFID transponders across a distance of several metres using a mobile handheld scanner leads to a significant simplification of inspection and maintenance work on complex equipment and lines such as those used in the chemical and pharmaceutical industries. Information such as installation date, seal type and supplier is right at the operator's fingertips. The maintenance process can be carried out, the new sealing system scanned and stored in the system and a new seal ordered – all without complex paper-based documentation and at high levels of efficiency.

Programming of customer-specific information is possible

The programming of customer-specific information on the O-ring and in the Parker Tracking System is one of the outstanding features of Parker's RFID technology. In addition to the unique identification number allocated to each RFID chip, a further, albeit limited, numerical code can be directly stored on the RFID transponder. Of course the Parker Tracking System can be programmed according to the customer's wishes as well. In this case, it will reflect exactly the type of information that is of interest to the customer.

The O-ring as a storage medium opens up completely new avenues

Parker's new generation of O-rings with embedded RFID transponders makes it possible to significantly expand the performance range of sealing solutions. Every single O-ring can be easily and effectively linked with customer-specific information, which opens up completely new approaches to managing sealing solutions in the customer's operations. Significant benefits in receiving area and warehouse management, tracking and component installation plus equipment maintenance are obviously achievable. ■

A special challenge to piston seals

Applications on corrosion-protected cold-drawn tubes

Low-cost cold-drawn hydraulic tubes with corrosion protection pose a special challenge to piston seals. In addition to the sealing compound's compatibility with the corrosion protection medium, the seal's geometry plus the quality of the tube surfaces is crucial to achieving an optimum of low-wear, and thus leakage-free, long-term reliable seal performance. As the findings obtained in extensive tests by Parker-Prädifa have shown, the seal manufacturer's application engineering consultancy is essential to finding suitable solutions for these requirements.

Thomas Papatheodorou
Manager Technical Services, Packing Division Europe

Hydraulic cylinders in a wide range of designs are used whenever large forces are transmitted in linear motion. Hydraulic cylinders deliver reliable, robust and leakage-free performance across long periods of time in applications ranging from automation processes to ceramic presses, from pitch cylinders in wind turbines to earth moving equipment or agricultural machinery. As hydraulic systems can be a significant cost factor, users tend to opt for designs that meet minimum rather than maximum requirements. All the major components of the hydraulic cylinder such as the piston seal, cylinder tube as well as the sealing and guiding system are assessed in terms of their performance capabilities and the cost-benefit ratio with the aim of finding a version that offers the greatest cost advantages for the job to be performed by the system.

Last but not least, a major focus in this context is placed on the piston tube itself. Besides ground, honed or rolled (steel) tubes, cold-drawn DOM (drawn over mandrel) steel tubes are being used today as mating surfaces for piston seals. These tubes provide a cost-effective alternative to the other tubes which involve more complex production processes.
Cold-drawn tubes are manufactured according to the European EN 10305-1 standard and are typically provided with corrosion protection. In this case, the compatibility of the corrosion protection medium with the sealing material should always be ensured.
During extensive investigations – carried out, among others, at Parker-Prädifa's inhouse test laboratory in Bietigheim-Bissingen – analyses were performed to identify the types of piston seals and sealing compounds which are suitable for use on the surfaces of cold-drawn tubes as well as the limits of their use in such applications. In addition, recommendations concerning the roughness of the piston tubes were developed to ensure satisfactory cylinder performance to the end user.

The dynamic and static tests were performed on the following **seal designs and materials:**

- Compact seals based on elastomers
- PTFE mechanical piston seals made of various compounds
- Piston seals based on polyurethane in varying degrees of hardness
- Piston seals based on UHMW-PE and other hard thermoplastics

Piston seals with varying profile widths were tested in each group. The smallest profile width was 3.9 mm whereas the largest compact seal tested had a profile width of approx. 15 mm and, in combination with the integrated guiding tapes, of more than 30 mm.
All the seals under test were measured before and after the endurance test and

Test conditions

To run the tests, a new rig was configured which allowed up to three trial seals to be simultaneously tested in a specified test tube.

All tests were run in the following conditions:

Pressure p:	0 to 250 bar depending on the piston's direction of travel, with the middle seal subjected to alternating pressure loading.
Oil:	HLP 46
Oil temperature T:	60 to 65 °C (plus in-process friction heat)
Travel:	220 mm
Load reversals:	250,000
Distance:	110 km

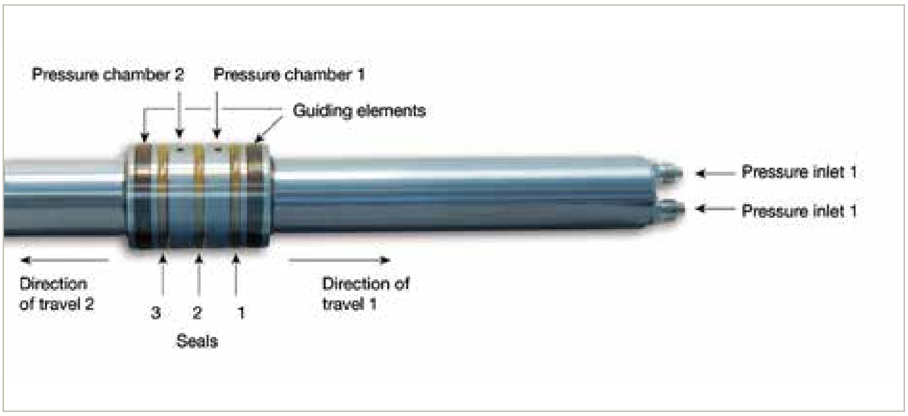


Figure 1: Trial piston with test seals and guiding tapes installed

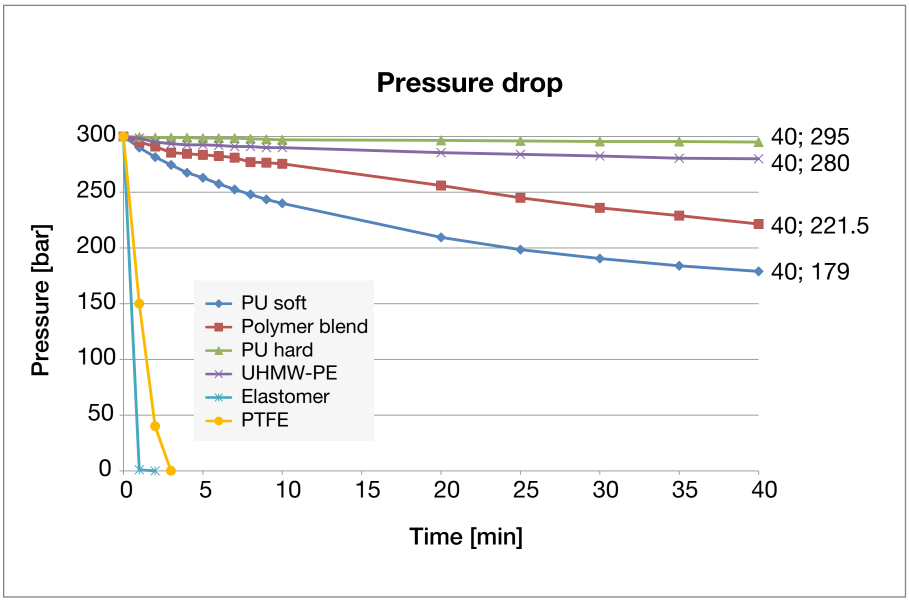


Figure 2: Results of pressure drop test

evaluated in terms of wear, deformation and extrusion. Possible changes in the mating surface (cylinder tube) were determined by means of roughness measurements and documented by optical evaluations under a microscope, with the roughness of the cylinder tubes measured before and after the endurance test.

Seal surfaces after endurance test

Fig. 3: TPU compound, soft

Fig. 4: TPU compound, hard

Fig. 5: UHMW-PE

Fig. 6: Polymer blend, hard

Summary of the test results

- With many of the tested piston seal geometries and materials – particularly in the case of seals made of soft elastomer and polyurethane compounds – pronounced abrasive wear was noted. In addition, some piston seals exhibited significant signs of extrusion and deformation along the seal's geometry.
- In the case of polyurethane-based piston seals it was noted that an increase in the sealing area and hardness of the material can significantly prolong the service life of the seals on drawn tube surfaces, which then exceeds the life of commercially available elastomer seals as well.
- Seals which due to their geometry and the compound used exhibit a high degree of self-heating under the specified test conditions can be expected to have a shorter service life.
- Elastomer-based seals initially show very good performance on cold-drawn tube surfaces. However, under certain circumstances – for instance if the seal, in addition to its self-generated heat, is loaded with the oil temperature from the hydraulic system – sudden seal failure can be expected.
- Particularly in the case of elastomer-based compact seal designs with integrated guide and back-up rings it is important to ensure that the actual sealing compound does not erode in contact with other plastic components.
- Piston seals based on hard thermoplastics, such as PTFE-filled compounds, have been found to be unsuitable for drawn tube surfaces whereas piston seals based on UHMW-PE may well be considered suitable for such tube surfaces.
- In applications on cold-drawn tubes a certain amount of axial scoring on the seal's surface due to potential pressure flow in the existing axial scoring of the tube surfaces is generally to be expected.
- With piston seals made of hard thermoplastics longer service life can be achieved than with seals made of elastomer compounds.

When using cold-drawn hydraulic tubes, particularly in applications where a large number of axial movements can be expected to occur within a relatively short period of time, it should be ensured that the tube surfaces meet certain minimum standards of roughness and material content. The roughness value R_z should not exceed 2 µm. If necessary, it is recommended to also measure crossways to the drawing direction in order to determine the peak-to-valley heights. Furthermore, the roughness value R_P, which describes the peaks on the surface, should not exceed 0.4 µm on the piston surface when using elastomer compounds. The higher the roughness of the tube surface the lower the life of the piston seals used.

Conclusion

A suitable sealing solution is essential to the user being able to actually benefit from the cost advantages of cold-drawn versus more complex ground, honed or rolled tubes in hydraulic cylinders. Close cooperation with an experienced seal manufacturer and use of the seal manufacturer's application engineering expertise provide the customer with optimum assurance of receiving a solution which despite challenging conditions delivers the prerequisites for low wear and thus leakage-free, long operational reliability.

A long version of this article has been published in the September 2012 edition of the magazine "O+P", Vereinigte Fachverlage, Mainz (Germany). ■

Reliably resists high pressures

HS static radial seal as an alternative to the current industry standard

As the saying goes, good is good, but better carries it. In this spirit, the Parker Seal Group consistently strives to make time-tested products even better. The HS radial seal developed by Parker is a case in point. It exhibits a number of strengths versus the existing industry standard for static sealing at high pressures – the combination of an O-ring and a back-up ring. Compared with the conventional, combined solution, it offers simplified assembly, higher sealing performance in pulsating pressures and longer service life.

O-ring/back-up ring combinations have so far been considered the industry standard for static applications at high pressures, but in field use they may exhibit weaknesses during the assembly process and in the application. Standard O-rings are often twisted during installation while back-up rings may not be installed in the proper position or damaged during assembly. Furthermore, this sealing combination may show certain weaknesses in pulsating pressures and under the influence of dirt.

None of this is the case with the new Parker Ultrathan® HS seal. The stable, symmetric geometry of the seal and use of particularly extrusion-resistant polyurethane compounds not only simplifies assembly but also enhances sealing performance in pulsating pressures, which significantly increases service life. Typical fields of application are hydraulic valves, hydraulic cylinders, machine tools and injection moulding machines as well as all radial static sealing areas in general.

Extreme leak-tightness and extrusion resistance

The HS seal is suitable for all standard O-ring grooves with back-up rings. However, the use of highly extrusion-resistant materials, particularly the P6000 polyurethane compound with a hardness of 94 Shore A, eliminates the need for back-up rings. The elimination of back-up rings delivers additional benefits in the form of simplified assembly.

The advantages of the HS seal result from the serial configuration of the two sealing areas which doubles the protection against leakage compared to a single seal. Furthermore, due to the seal being supported by two sealing areas or sealing edge pairs, exceptional protection against twisting of the seal is achieved. This is the case during installation as well as in operation, for instance when pulsating pressures occur in combination with breathing assembly components and coaxial defects of the groove.

Benefits that pay off

In view of the wide-spread use of O-ring/back-up ring combination seals the advantages of the single seal, HS, offered by Parker as an alternative to the existing industry standard pay off for the user in a very short time. For one, easier assembly reduces manpower requirements and ensures that the system is “up and running” again whenever a seal has to be exchanged. Even more important though are factors such as higher operational reliability resulting from the proper positioning of the seal and elimination of the twisting risk plus longer service life and higher sealing performance. Due to the reduced risk of leakage the new solution ultimately provides higher safety when it comes to compliance with environmental requirements – an aspect that is particularly relevant to many system operators especially in the field of hydraulics. ■

Fabio Bueti, Application Engineer
Packing Division Europe

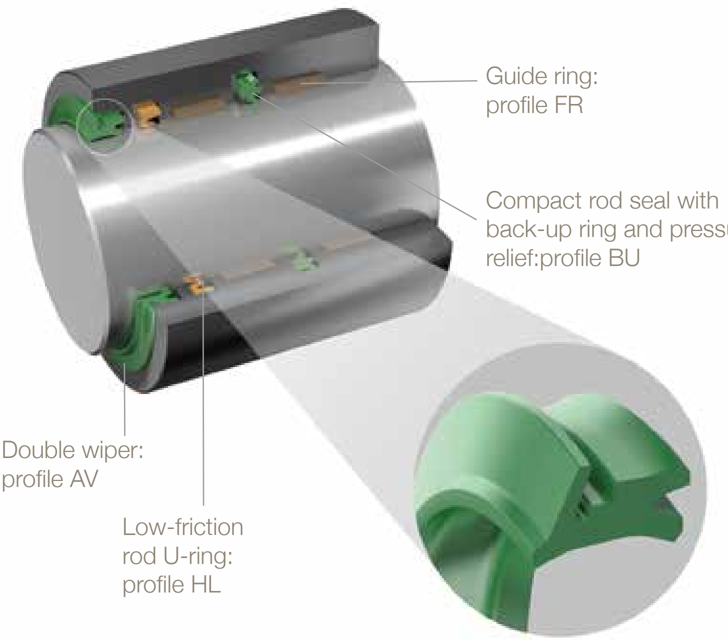
Armed against dirt

New wiper with integrated "dirt shield"

Contamination by dirt or the intrusion of dirt into cylinders is the most common cause of failure in mobile machines. As operating cycles and working conditions of the machines and equipment continue to rise high availability is of crucial importance to all end users.
The AV wiper by Parker-Prädifa provides effective protection against system contamination and corrosion and thus contributes to the high availability of mobile machinery.

The wiper is the major element on the hydraulic cylinder to prevent the intrusion of dirt. It protects the entire hydraulic system against, dust, dirt, moisture and other environmental influences. Due to increasingly sensitive elements being used within hydraulic circuits the wiping function has been steadily gaining importance as contaminated fluid systems are common causes of total failures with high consequential costs.

Performance data	
Operating temperature	-35 to +100 °C
Sliding speed	≤ 2 m/s



Sealing system example

To improve the wiping function Parker-Prädifa has developed a special wiper profile with the following features:

- Dirt shield
- Dirt sealing edge on the groove side
- Double wiper
- Pressure relief drill hole
- Optimised wiper lip geometry
- Time-tested sealing function due to robust seal profile

Range of application

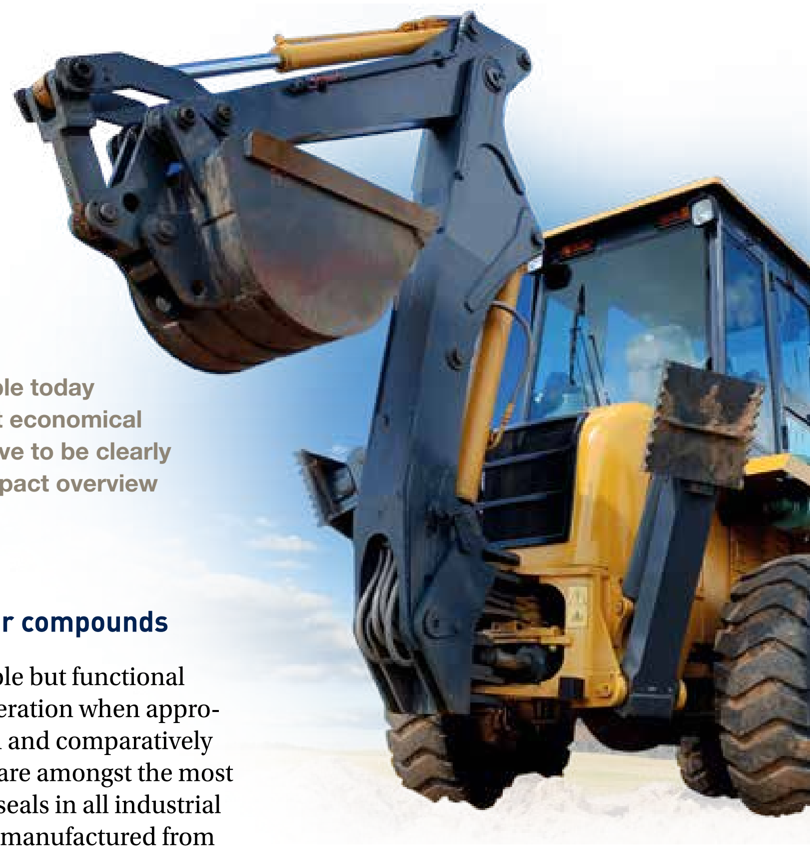
The AV wiper can be used in all hydraulic cylinders and is particularly well-suited for mobile applications. The moulded dirt shield on the wiper prevents the migration of moisture underneath the wiper in the groove. The common occurrence of corrosion in the groove can thus be avoided. In applications with a vertically positioned piston rod head (piston rod head pointing up-wards) the dirt shield to protect the seal groove is particularly effective. Water running down the piston rod is diverted and does not enter the wiper groove. Due to the press fit in the housing and the pressure relief drill hole the risk of the wiper being pushed out of the cylinder housing is minimised. ■

Dr.-Ing. Peter Kreißl
Market Unit Manager Hydraulics,
Packing Division Europe

Static sealing tasks concisely defined

A brief guide to selecting the right solution

Christoph Meissner, Application Engineer
Thomas Braun, Marketing & Engineering Manager
Packing Division Europe



In view of the wide variety of static seals which are available today the decision criteria for selecting the best suited and most economical solution to meet the needs of the particular application have to be clearly defined. The key considerations are presented in this compact overview as an orientation aid for developers and users.

Factors that influence the selection of seals

Apart from commonly occurring factors such as

- Pressure, pressure curve
- Temperature
- Medium (compatibility, viscosity, ...)
- Space requirement
- Assembly conditions (accessibility, deformation, sharp edges, automation, …)
- Required sealing effect
- Costs
- Material and surface quality of the sealing area
- Presence of dirt
- Required approvals (drinking water, foodstuffs, …)
- Safety relevance

other, more specific, factors may play a role. The types of influences that are relevant in an application and their respective significance have to be properly examined and play a crucial part in selecting the appropriate seal. Parker-Prädifa offers a large selection of sealing systems to match the specific application requirements and will of course assist customers in making their selection by providing the requisite technical consultancy.

O-rings made from elastomer compounds

Due to their simple but functional form, reliable operation when appropriately designed and comparatively low cost O-rings are amongst the most commonly used seals in all industrial sectors. They are manufactured from various materials, particularly elastomers such as NBR, EPDM, FKM etc. O-rings are frequently used in combination with (harder) back-up rings that prevent the (soft) O-ring material from migrating into the sealing gap (gap extrusion) and destroying the seal.

Back-up rings can be made from various materials such as polyamide or POM for large volumes. PTFE with its broad chemical and thermal resistance is another widely used material and quickly available in all conceivable dimensions due to the fact that the parts are produced by machining. Whenever maximum demands are made on strength at high temperatures PEEK compounds may be the best choice.
As these materials lack elasticity back-up rings often have to be slotted. Alternatives in these cases are back-up rings made from thermoplastic elastomers or Parbak® back-up rings from hard rubber. Parbak® back-up rings are available in NBR and FKM materials for standard O-ring sizes.

O-rings made from polyurethane

Thermoplastic elastomers such as polyurethane are becoming increasingly attractive for use in static applications. Thanks to their exceptional strength they offer high extrusion resistance in hydraulics at high pressures, which often eliminates the need for back-up rings. Consequently, the variety of parts as well as the risk of mistakes being made in assembly can be reduced. High abrasion resistance is an additional advantage of polyurethanes. Traditional weaknesses of polyurethane compounds such as limited temperature resistance and sensitivity to hydrolysis have meanwhile been eliminated by further developments and allow these materials to be used in new applications. In addition, the compounds exhibit advantageous mechanical properties so that polyurethane O-rings frequently serve as static seals in valves, pumps, hydraulic cylinders or connecting elements today.

Static sealing elements – radial sealing

≤ 60 bar	≤ 350 bar	≤ 600 bar	≤ 5000 bar
O-Ring (rubber) Temp.: -50 / +300 °C	**O-Ring (rubber) + Parbak® back-up ring (rubber)** Temp.: -50 / +200 °C	**O-Ring (rubber) + back-up ring (PTFE)** Temp.: -50 / +300 °C	**Metal seal, resilient – EnerRing®** Temp.: -200 / +1000 °C
	Quadring (rubber) – Tetraseal® Temp.: -40 / +200 °C	**O-Ring (TPU)** Temp.: -50 / +100 °C	
		Static radial seal HS (TPU) Temp.: -50 / +100 °C	
		Spring-activated PTFE Seal – FlexiSeal® Temp.: -200 / +300 °C	

Profile seals made from polyurethane

Polyurethane seals can even be used at pressures up to 600 bar as illustrated here by the example of Parker-Prädifa's HS and OV seal profiles.

The **HS static radial seal** (see article on page 9) is suitable for all standard O-ring grooves with back-up rings. However, thanks to the use of particularly extrusion-resistant compounds back-up rings are not required in this case. The fortes of the HS seal result from the sequential configuration of the two sealing areas. The advantages in brief: double protection against leakage and an exceptional safeguard against twisting of the seal both during installation and operation.

The **OV flange seal**, which has been optimised for maximum extrusion resistance, with dimensions for flanges according to SAE J518 and DIN ISO 6162 is axially compressed. Despite its good elastic properties the polyurethane compound exhibits high strength while the shape ensures that the sealing area is not in close proximity to the sealing gap. This leads to long service life with extended maintenance intervals.
OV flange seals can be used at pressures up to 600 bar and temperatures between -35 and +100 °C. Special compounds, for instance with optimised low-temperature properties, improved media resistance or FDA approval for food applications are available for these seals.

Composite sealing washers

Composite sealing washers are typically used to seal threaded or flanged connections. They consist of a metallic ring with rectangular cross section and a vulcanised elastomer sealing lip for which various profiles are available.
The metal ring provides a firm stop when the screw is tightened, thus preventing damage to the elastomer part.

The compression of the elastomer art is precisely defined by the height of the metal ring, which allows maximum sealing performance to be achieved. Assembly is easy. A groove is not required. The extremely small sealing gap that results from the tightening of the screw provides exceptionally high pressure resistance. Sufficient quality of the sealing areas provided, composite sealing washers can be used at pressures up to 2000 bar and temperatures between -50 and +200 °C.

PTFE seals

An exceptionally wide temperature range and resistance against nearly all conceivable media make PTFE a good choice for challenging application requirements that exceed the capabilities of standard elastomers. Although the basic PTFE material exhibits properties such as sensitivity to abrasive particles and insufficient elasticity, which tend not to favour its use in sealing applications, these disadvantages can be effectively compensated for by means of certain filler materials. A variety of solutions is available for this purpose.

Static sealing elements – axial sealing

≤ 60 bar	≤ 350 bar	≤ 600 bar	≤ 5000 bar
O-Ring (rubber) Temp.: -50 / +300 °C	**O-Ring (rubber) + Parbak® back-up ring (rubber)** Temp.: -50 / +200 °C	**Flange seal OV (TPU)** Temp.: -50 / +100 °C	**Metal seal, resilient – EnerRing®** Temp.: -200 / +1000 °C
Composite sealing plate – Gask-O-Seal® Temp.: -50 / +300 °C	**Quadring (rubber) – Tetraseal®** Temp.: -40 / +200 °C	**Composite sealing washer** Temp.: -50 / +200 °C	
	Axial case seal for hydraulic pumps/ motors Temp.: -40 / +200 °C	**Spring-activated PTFE seal – FlexiSeal®** Temp.: -200 / +300 °C	

Elastomer-activated PTFE seals – Slipper Seals
In the simplest variant a conventional elastomer O-ring is combined with a PTFE slide ring. In this case, the sealing element is limited to the permissible operating parameters of the O-ring elastomer. The Parker-Prädifa product portfolio offers the CP and CR profile ranges in this category for static sealing points. The cross-sections of these profile ranges fit into standard O-ring grooves.

Spring-activated PTFE seals – FlexiSeals®
The elasticity of PTFE seals can also be achieved through metallic spring elements. They are fixed in the centre of the seal's cross-section in such a way that they cause the initial contact pressure forces to be exerted in an optimised direction after assembly. The springs are typically snapped into undercuts of the geometry and, in addition, welded into continuous rings to achieve a homogenous stress situation across the entire circumference of the sealing elements.

Complementing PTFE as a material choice are hard high-performance plastics such as UHMW-PE or PEEK, which make an enormous increase of extrusion resistance possible. Some of the standard profile ranges from Parker-Prädifa are also suitable for sporadic and short-term intermittent loads such as micro-motion or relative motion caused by thermal elongation.

Resilient metal seals – EnerRings®

Resilient metal seals – arguably the most exclusive static seal variant in existence at the moment – are available in various cross-section shapes such as C-rings. Compared to conventional copper rings EnerRings® are characterised by their elastic resilience. They resist even the harshest conditions such as very high or very low temperatures, high pressures or ultra-high vacuums, aggressive chemicals or even radioactivity for years. EnerRings® are produced in standard profile cross-sections and can be manufactured for practically any diameter. These seals, as well, are categorised as flange seals and radial sealing solutions. ■

One groove – unlimited potential

Modular kit for rod-side seal-wiper elements in pneumatic cylinders

The housing, which is identical for all sealing elements of the EU system, allows easy refitting of the pneumatic cylinders for different requirements. The seals are installed into the open housings by means of a handling tool.

- Standard: Profile EU
- Dry running, aggressive chemicals,extreme temperatures: Profile E7
- Harsh application conditions: Profile E8
- High temperatures: Profile E9
- High temperatures and risk of contamination by dirt: Profile EW
- Hygienically sensitive applications: Profile EN

Parker-Prädifa offers a large number of combined pneumatic rod seals and wipers for the open groove of the EU system. By installing the right type of seal a wide range of applications can be covered with just one cylinder design. Another advantage: Thanks to the open groove the seals are very easy to install and remove. Now two more seal profiles have been added to the modular kit: series EN for hygienically sensitive applications and series EW For use at high temperatures and risk of contamination by dirt with extremely adherent dirt particles.

EN seal-wiper ring for pneumatic cylinders in hygienically sensitive applications

The newly developed, self-retaining EN seal-wiper ring for piston rods of pneumatic cylinders performs three functions: sealing, wiping and fixing. The EN profile consists of the proven geometry of the EU profile with a double, flexible sealing lip plus a new wiper lip that is combined with a cover cap. The cover cap protects the seal and the cylinder against the intrusion of fluids and dirt particles. Due to the simple geometry of the cover cap the housing in front of the seal can be easily cleaned as there are no undercuts or dead spaces. The EN seal-wiper ring is thus particularly well suited for the food and pharmaceutical production as well as for all other fields of application requiring an enviroment that is easy to clean.

Range of application

Clean room technology

Pneumatic cylinders are used particularly in automated clean room technology. In printed circuit board (PCB) assembly operations, for instance, it is im-portant to keep the PCBs free from any foreign particles. The seal, which has no dead space, ensures that no particles are trapped in undercuts where the formation of deposits and contaminations would result in flawed PCB assembly for the manufacturer.

Medical technology/ pharmaceuticals
The example used here is the production of pharmaceuticals. The media can be processed in both solid and liquid form in such applications. In either form, it was possible for dust and drops of liquid to deposit in the undercuts of the previous version. Such deposits can have devastating consequences in the event that they cause premature reactions or contaminate the preparations. The cover cap prevents such deposits and makes easy cleaning, for instance by spraying or steaming, possible.

Food processing
In the field of perishable fluids and media, smooth and easy to clean areas are important. The cover cap on the wiper prevents the formation of residual particle deposits which might cause the growth of bacteria and fungi. For crystalline media particularly wear-resistant compounds are available.

EW seal-wiper ring for use in pneumatic cylinders at high temperatures and risk of dirt

The EW seal-wiper combines the properties of the time-tested E9 high-temperature seal with a metallic wiper for environments that are particularly prone to dirt. The EW profile, in addition to the known functions of sealing and fixing, thus offers an extended wiping range. The metallic wiper permanently protects the piston rod against firmly adhering abrasive particles and the seal from excessive wear. A significantly prolonged service life is achieved through the combination of a metallic wiper and a wear-resistant sealing compound.

Range of application

Aluminium extraction
In the aluminium production process a crust consisting of alumina and various fluoride compounds forms on the melt. The crust breaker cylinder has to break up the crust so that the melt can be supplied with other reaction agents. During this process melt and slag substrates deposit on the piston rod. The multifunctional EW sealing element has been developed to achieve a continuous crust breaking process. It removes the crust from the rod by means of the metallic lamella wiper. Due to the use of the metallic wiper versus conventional polyurethane wipers service life can be significantly extended.

Industrial enamelling furnaces
Further fields of application are all dry and porous-crystalline media such as brick dust, ceramic particles or cement dust that easily deposit on and adhere to the piston rod and would cause permanent wear.

Automotive industry
For interior sealing of automotive bodies waxes are applied by means of robotics. During the application process these waxes deposit and crystallise on the rod. The metallic wiper in front of the seal continually wipes these deposits off the piston rod to create a proper working environment for the seal. Without this metallic wiper the seal is exposed to the risk of wear and sticking to the piston rod.

Coolant/refrigeration industry
The EW seal-wiper is primarily used on piston rods that are exposed to regular temperature changes, which can cause the rods to freeze. A pneumatic cylinder on refrigeration machines or doors is a classic application example. When opening the door of a refrigerator truck or room the resulting condensation deposits and freezes on the rod. The metal wiper in front of the seal removes the ice from the rod, which makes it possible to achieve clearly prolonged service life compared to standard wipers.

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Sealing compounds for food and pharma production

Critical tasks, harsh conditions and numerous regulations

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From germs found in ice cream, mineral oil in chocolate or sprouts with EHEC bacteria, contaminated foodstuffs unfortunately continue to make headlines from time to time. Therefore, to protect consumers, increasingly stricter requirements have been imposed on the food and pharmaceutical industries in terms of process and equipment safety in recent years. This also applies to the seals used in such equipment and the compounds they are made from.

To ensure that products which are intended for human consumption are as safe as possible the production processes and equipment used in the food and pharmaceutical industries have to comply with numerous legal or government regulations. A particular focus in this context is placed on ensuring protection against biological and chemical contamination through compliance with specific hygienic requirements and sterile processes. In line with their functional purposes seals, among other things, have to reliably prevent process media such as cleaning agents or solvents from coming into contact with the product but must not release any of their own compound ingredients to the product in the process. This is a challenging task in increasingly hot and aggressive operating conditions.

Tough service under heat and pressure

In the production processes of foodstuffs, beverages and pharmaceuticals, the spotlight is focused on growing demands concerning sterility met by "CIP" (Cleaning in Place) and "SIP" (Sterilisation in Place) and the associated higher cleaning temperatures. These fast and efficient cleaning methods assure that neither germs nor dirt or cleaning agents make entire batches of these hygienically sensitive and valuable products unfit for use. But in combination with heat and pressure the cleaning agents make harsh demands on the elastomer seals used in the equipment as well. In addition, the seals have to resist both alkaline and acidic cleaning media as well as polar and non-polar solvents for prolonged periods of time while assuring their functionality and sealing effect. In the core process of active pharmaceutical ingredient (API) production, the highly varied reactions, reactor types and speeds make maximum demands on the safety and reliability of the sealing systems. Furthermore, the development of micro-organisms in pumps and valves has to be prevented through a hygienically conformant design of the seals that avoids gaps and traps as well as by flow-optimised bending radii of pipe and tube systems.

Excellent sealing compounds

With their excellent resistance to steam and challenging polar chemicals, **ethylene propylene rubbers (EPDM)** have been found to deliver optimum performance in CIP/SIP cleaning and sterilisation media with application temperatures ranging from -40 to +150 °C. In applications with fatty and oil-based fruit extracts such as citrus and orange aroma substances requiring good acid and alkaline resistance fluoroelastomers are the material of choice.

Thanks to their increased fluorine content the **HiFluor® (FKM)** compounds exhibit very good resistance when used in high-fat foodstuff and beverage manufacturing operations or in the production of oil- and fat-based pharmaceuticals up to +250 °C. Universal chemical and thermal resistance are the characteristics of the **Parofluor® (FFKM)** compounds which are successfully used in steam at temperatures of >150 °C. They provide prolonged operating reliability and allow maintenance intervals to be extended.

materials comply with Regulation (EC) No. 1935/2004 as well.
This ensures that the sealing materials do not release any ingredients to foodstuffs, that they pose no hazard to human health and that they cause no unacceptable alterations of the composition of the foodstuffs.

USP (United States Pharmacopeia) Class VI
The results protocol of USP Class VI even takes this a step further. It attests to the biological compatibility with living organisms and thus the harmlessness of the sealing materials to health. The most important test protocols are

- USP Class VI, Part 88, Biological reactivity test, in vivo. It is designed to determine the biological response of animals to elastomers, plastics and other polymeric materials in direct or indirect patient contact, or by the injection of specific extracts prepared from the material under test.

- USP Class VI, Part 87, Cytotoxicity test, biological reactivity test, in vitro. It is designed to determine the biological reactivity of mammalian cell cultures following contact with the elastomeric plastic and other polymeric materials with direct or indirect patient contact or specific extracts prepared from the material under test.

PTFE (Polytetrafluorethylene) compounds with their broad chemical and thermal resistance are perfectly suited for use in chemical and pharmaceutical production processes as well. In addition, they excel in terms of offering extremely low friction.

Furthermore, tailored **polyurethane (TPU)** materials, which are resistant to cleaning media, acids and alkaline solutions and have been awarded relevant approvals for use with foodstuffs and drinking water, are available.

Government regulations

Apart from the process and cleaning conditions, plant and equipment operators are confronted with a flood of government regulations and desired warranty conditions, all of which are aimed at protecting the consumer. International, European and national regulations are increasingly often incorporated into specifications even in the event that, to some extent, they may not be relevant to the specific application.

Food and Drug Administration (FDA) / Regulation (EC) No. 1935/2004
Parker has developed sealing compounds that meet the extensive requirements of the U.S. Food and Drug Administration (FDA) and almost completely cover the entire spectrum of chemical resistances at temperatures from -50 to +300 °C.
In line with the relevant FDA rules they contain no substances rated as toxic or carcinogenic and are therefore suitable for use in food processing, bio technology or pharmaceutical industry equipment. They thus comply with FDA No. 177.2600, CFR 21 ("Rubber Articles Intended for Repeated Use").
These compound mixtures conform to the European Regulation (EC) No. 1935/2004. Annex I to this European directive lists groups of materials and articles for which individual actions can be imposed. However, for "rubber" and "silicones" there have been no individual actions defined and together with the German Engineering Association (VDMA) industry has agreed that FDA-conformant sealing

Big success for smallest consumers

In addition to numerous excellent Parker-Prädifa sealing materials, the outstanding E8743-70 EPDM compound that has been successfully used for many years in the production of baby food deserves particular mention. This application makes extremely high purity demands on aseptic processes. The material is characterised by a range of technical properties such as exceptionally high resistance to CIP/SIP cleaning media, in hot water, steam, ketones, alcohols, acids and alkaline solutions, at temperatures ranging from -50 to +150 °C. The E8743-70 sealing compound complies with FDA No. 177.2600, CFR 21, meets the requirements of European Regulation (EC) No. 1935/2006, Regulation (EC) No. 1907/2006 "REACH" and is both ADI- and plasticiser-free. Furthermore, customers value the very good resilience, high wear resistance, prolonged service life and associated high operating reliability of this outstanding material.

Bundesamt für Risikobewertung (BfR)
The German Federal Agency for Risk Assessment (BfR) issues recommendations with respect to ingredients, additives, residues and contaminants in foodstuffs and animal feed. Parker-Prädifa will issue so-called BfR certificates for defined sealing compounds on request.

Free from Animal Derived Ingredients (ADI-free)
Parker-Prädifa has developed formulations for sealing compounds which are ADI-free (= free from Animal Derived Ingredients). The FDA and the European Union took up this topic after the occurrence of BSE (bovine spongiform encephalopathy) due to the various resistances of BSE pathogens (highly resistant protein molecules) and recommend the use of ADI-free sealing materials if the materials come into direct contact with foodstuffs and pharmaceuticals. Ingredients derived from animal fats and oils – such as stearic acid – can migrate into the materials via polymerisation.

REACH – Regulation (EC) No. 1907/2006
Regulation (EC) No. 1907/2006, also known under the acronym of "REACH" (Registration, Evaluation, Authorisation and Restriction of Chemicals) registers, evaluates, authorises and restricts chemical substances, such as the use of lead, in order to minimise potential hazards. All Parker-Prädifa seals manufactured and sold in Europe are REACH-compliant.

3-A Standards
3-A Standards Inc. is a hygiene organisation of the U.S. food industry that defines standards and rules for the development, production and use of equipment, particularly in the dairy industry. Seals installed in dairy equipment shall comply with the 3-A Standards by subjecting them to a suitability test which qualifies them.

Free from plasticisers
Furthermore, the seals used must not contain any plasticisers (phtalates) as these substances are suspected of influencing the hormone system and may cause infertility, liver damage or diabetes.

Italian speciality

Perfect cylinder/seal combination for "salumi"

Since the company was formed thirty years ago, ARTEC S.R.L. based in the Northern Italian town of Cento has made a name for itself as a manufacturer of compact, short-stroke cylinders, technical accessories such as angular grippers as well as oil and air tanks for the domestic and foreign markets.

The quality products, which are completely developed and produced in-house at ARTEC in Italy, are used in a wide range of industrial sectors, from the automotive all the way to the pharmaceutical industries.
In the production of pneumatic cylinders for the food industry ARTEC relies on the seals specifically tailored to the needs of hygienically sensitive applications and food-grade sealing compounds by Parker-Prädifa. A series X cylinder made of AISI 316 stainless steel used in the production process of steam-cooked ham, an Italian "salumi" speciality appreciated by gourmets around the world, is a case in point. The perfectly coordinated combination of the cylinder and sealing system has made it possible for the ham producer to significantly increase the plant's efficiency and productivity, not least thanks to lower maintenance requirements.

New publications

- **AV Wiper**
  Armed against dirt
- **EN seal-wiper ring**
  For pneumatic cylinders in hygienically sensitive applications
- **EW seal-wiper ring**
  Use in pneumatic cylinders at high temperatures and risk of dirt
- **Sealing systems in gas springs**
  Serving to enhance consumer comfort and industrial productivity
- **HS Static radial seal**
  Static sealing for high-pressure applications

All publications are available in English and German and can be ordered via e-mail at seal-europe@parker.com.

Event Calendar

Hanover Fair	Hanover, Germany	08.04. – 12.04.2013
Medtec France	Lyon, France	15.05. – 16.05.2013
Paris Airshow	Paris, France	17.06. – 23.06.2013

We look forward to your visit.

In top form with "form-in-place"

Compound solutions for EMI shielding and sealing of electronic equipment

Christophe Loret, Product Manager Conductive Compounds
Chomerics Division Europe

Mobile electronic devices are even being used in the most remote parts of the world today. Their operation crucially depends on effective EMI shielding that prevents interferences between different systems. Furthermore, the sensitive electronic components must be protected against external influences such as moisture or dirt. Parker offers advanced solutions by its Chomerics Division that meet the various shielding and sealing requirements of both small-sized devices and larger equipment in effective and low-cost ways based on a wide range of compounds and technologies such as form-in-place gaskets.

In 2013 people everywhere are carrying around technology that just one or two decades ago was unimaginable – pocket-sized devices that can pinpoint location, take and transmit photographs, set up video calls on the move, remotely manage security systems, and perform many other functions now considered essential for everyday living.

Tightly packaged devices require careful EMI management

Today's high-tech devices are typically highly miniaturised and often combine multiple radios such as 3G, Bluetooth® and WiFi® connectivity in smartphones and tablets that may cause or suffer interference if not properly shielded. Demands for miniaturisation, as well as increased energy efficiency to meet new eco-design regulations and extend battery life, are also driving increased adoption of switched-mode circuits such as class-D amplifiers and DC/DC converters that demand careful attention to managing electrical switching noise.

Sensitive components require protection from external influences

In addition to requiring electromagnetic interference shielding, the sensitive components have to be protected from water or moisture, chemicals and tiny dirt particles entering compartments or enclosures as any of these may prevent circuitry from operating correctly or cause corrosion that may lead to early failure. Moreover, enclosures and housings must be low-cost and easy to assemble.

Advanced form-in-place technologies for various demands

These trends encourage the use of form-in-place gaskets for EMI shielding and sealing in electronic equipment. Gaskets are deposited during assembly using software-controlled precision equipment to place an elastomeric bead around the perimeter of the enclosure or compartment to be shielded. The technology is recognised as an effective and economical way of protecting sensitive devices and is suitable for use from prototyping and new product introduction right up to high-volume continuous production.
Parker Chomerics' CHOFORM® and ParPHorm® Form-In-Place (FIP) technologies provide a choice of formulations that allow product developers and manufacturers to achieve an optimal blend of properties for their applications.

EMI shielding and sealing

CHOFORM® is chosen where EMI shielding as well as sealing properties are required. Typical applications are in compartmentalised enclosures and other tightly packaged electronic devices in military, telecom, transportation, aerospace and life-science applications. Form-in-place properties can reduce the installed cost of an EMI gasket by up to 60 %, compared with a conventional pre-formed gasket.

High-performance sealing

Parker Chomerics' ParPHorm® family comprises non-conductive elastomeric sealing compounds. They are chosen for high resistance to a wide variety of fluids, excellent substrate adhesion, low hardness, and outstanding compression-set properties.

CHOFORM® thermal-cure compounds

- CHOFORM® 5508: >70 dB EMI shielding, Silver/Copper (Ag/Cu) filler, suitable for indoor applications
- CHOFORM® 5550: >65 dB EMI shielding, Nickel/Graphite (Ni/C) filler, low-cost, good galvanic corrosion resistance for outdoor use with aluminium enclosures, low hardness
- CHOFORM® 5560: >90 dB EMI shielding, Nickel/Aluminium (Ni/Al) filler, displaying best corrosion resistance with aluminium for harsh salt-spray/salt-fog environments

CHOFORM® moisture cure compounds
(curing at room temperature)

- CHOFORM® 5519: >70 dB EMI shielding, Silver/Copper (Ag/Cu) filler, lowest hardness grade with 35 Shore A for indoor applications where low closure forces are needed
- CHOFORM® 5572V: >65 dB shielding, Silver/Aluminium (Ag/Al) filler, for harsh salt-spray/salt-fog environments
- CHOFORM 5557: >70 dB shielding, Silver/Nickel (Ag/Ni) filler, good corrosion resistance, fully cured in only 7 hours at room temperature and 50 % relative humidity
- CHOFORM 5538: >65 dB shielding, Nickel/Graphite (Ni/C) filler, low cost, good corrosion resistance with aluminium, best for applications requiring the smallest possible bead size

ParPHorm® compounds

- ParPHorm® S1945: thermal cure, 25 Shore A hardness, 21 % compression set, low closure force, good adhesion to aluminium, phenolic resins, copper, stainless steel, glass, rigid PVC, most ceramics, plastics
- ParPHorm® 236: moisture cure, 25 Shore A hardness, designed to operate continuously from -65 to 260 °C and intermittent exposure up to 315 °C
- ParPHorm® 373: moisture cure, 35 Shore A hardness, for applications requiring solvent and/or fuel resistance
- ParPHorm® 1071: moisture cure, 52 Shore A hardness, adhesion to most common substrates, for high-performance sealing applications

Innovation for integration

The integration and interconnection of various electronic components, devices and systems in industrial, public- and private-sector applications and networks is progressing in giant leaps. Through its range of innovative shielding and sealing solutions, continuous further development of existing and new products plus extensive application engineering support and consultancy Parker Chomerics helps to bring the wealth of ideas of electronics developers to fruition in ways that minimise costs and contribute to trouble-free operation. ■

The best from two worlds

New compound generation for biofuel systems

Dr Heinz-Christian Rost, Technology and Innovation Manager
Bekim Berisha, Market Unit Manager Automotive
O-Ring Division Europe

Today, biofuels represent the most important alternative energy source in transport. In Germany, they account for around 5.6 %, in Europe for 4.5 % and worldwide for a little more than 2 % of the total automotive fuel consumption. Due to the differences in the chemical composition of biodiesel and bioethanol compared to conventional diesel and petrol fuels the seals used in the fuel systems of modern vehicles have to meet special demands. With a new generation of FKM compounds – V8890-80 and V8880-80 – Parker-Prädifa has successfully performed the balancing act of delivering the required biofuel compatibility and necessary cold flexibility.

Even though fossil fuel resources are far from having been depleted, efforts to make more extensive use of renewable energies have been gaining enormous importance in the transport sector as well. Continually rising carbon dioxide levels in the atmosphere and the resulting increasingly stringent emission standards imposed by environmental regulations around the world are one of the reasons for this. At the same time, industry has discovered the huge potential that lies in the production and marketing of low-emission fuels derived from eco-friendly products or agricultural by-products.

Biofuels, however, vary. Some biofuels are produced from common crops. Bioethanol, for example, is produced from sugar cane whereas biodiesel is made from rapeseed oil or soybean oil. Alternative fuels can also be produced from the bio mass of seaweed or bacteria. Fig. 2 depicts the relevant chemical path.
By 2020, biofuels will be making the major contribution to achieving the stated EU target of 10-per cent use of renewable energies in road transport. By 2050, the share of biofuels is supposed to increase to a level of up to 70 %.

Special challenges posed to sealing materials

The growing share of biofuels in the fuel mix poses special challenges to the components that come into direct contact with them, which obviously includes the sealing elements in the fuel systems. For instance, the chemical composition of bio diesel – and even more importantly in this context that of bioethanol – fundamentally differs from conventional diesel and petrol fuels. It requires new performance characteristics in terms of media compatibility both at high and very low application temperatures.

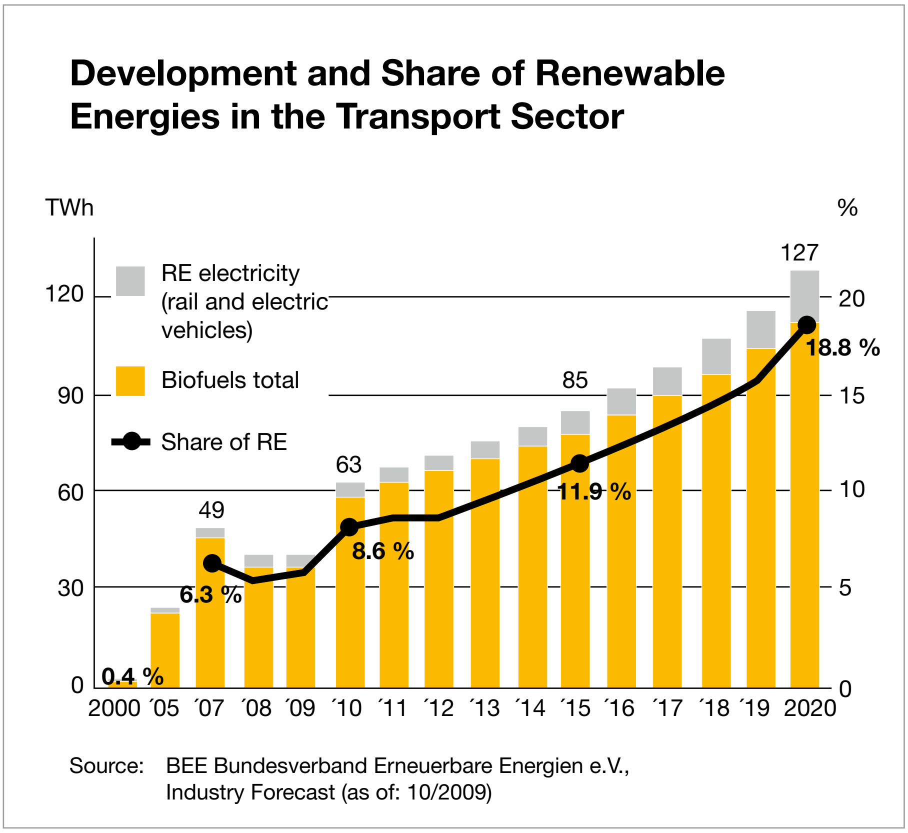

Fig. 1: Market share of renewable energies in Germany

Successful balancing act between media compatibility and cold flexibility

By developing a new generation of FKM compounds - V8890-80 and V8880-80 – Parker-Prädifa has successfully performed the balancing act between media compatibility and cold flexibility. Both compound solutions exhibit a solid elastic performance profile in combination with good compression set and cold flexibility at low (TR10: -29 °C) and ultra-low temperatures (TR10: -39 °C – see Table 1).

The physical properties of Parker-Prädifa's standard FKM compounds V8684-75 and V8802-80 are summarised in Table 1. Whereas V8684-70 is characterised by outstanding biofuel compatibility this compound has disadvantages with respect to cold performance. By contrast, V8802-80 with a TR10 value of -29 °C, exhibits its outstanding cold flexibility but ranks only in mid-field in terms of media compatibility. The reason for

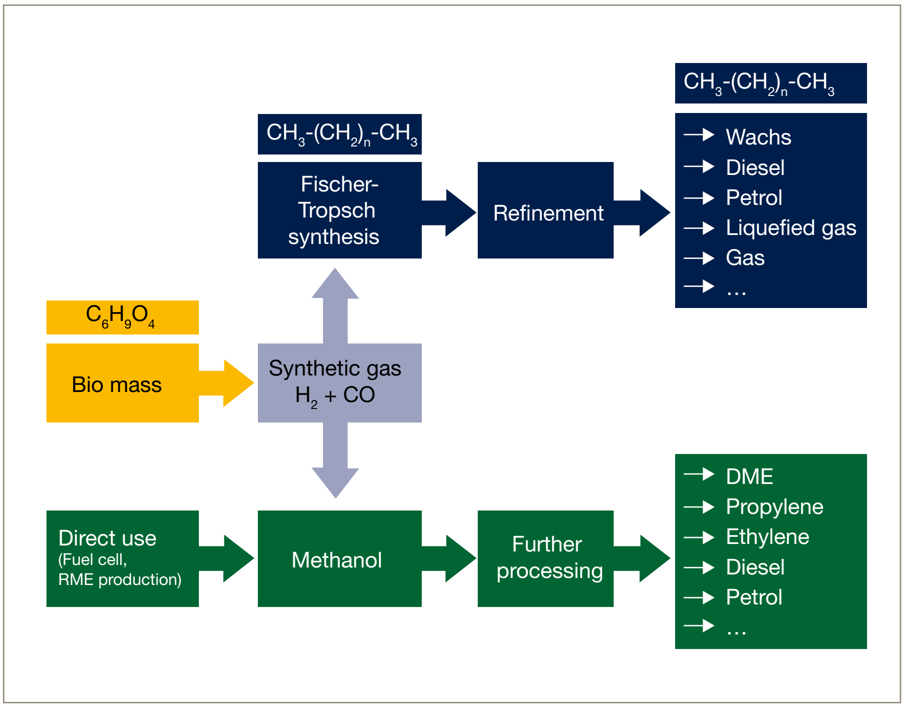

Fig. 2: Chemical paths from bio mass via synthetic gas to synthetic fuels and base chemicals (DME = dimethylether). (Source: Dinjus/Dahmen Week 12, Year 2008)

Test	Standard	Dimension	V8684-75	V8802-80	V8890-80	V8880-80
Elastomer base			FKM	FKM	FKM	FKM
Colour			green	blue	purple	green
Hardness	DIN 53505	Shore A	75	81	82	82
Modulus (100 %)	DIN 53504	N/mm^2	5.5	9.4	8.7	8.5
Tensile strength	DIN 53504	N/mm^2	13.3	13.1	11.4	10.9
Ultimate elongation	DIN 53504	%	260	210	167	161
Low temperature properties TR10	ASTM D 1329	°C	-7	-29	-29	-39
Compression set 70 h / 200 °C	ISO 815 / 7.5.1	%	31	22	23	25

Table 1: Comparison between the previous and the new generation of bio-compatible Parker FKM compounds

this obvious contradiction is the fact that media compatibility – and thus biofuel compatibility – is typically related to the fluorination degree of the polymer backbone. In other words, the higher the degree of fluorination the better is media compatibility. At the same time, though, the degree of fluorination causes a decline in cold flexibility because the flexibility of the polymer backbone decreases.

The new generation of Parker FKM compounds with low-temperature capability sets new standards with respect to cold flexibility in combination with biofuel compatibility, as the comparison between the previous and the new generation in Table 1 shows as well. V8890-80 with a TR10 value of -29 °C exhibits the outstanding ethanol and methanol resistance which had previously been achieved only by FKM materials such as V8684-75 with a TR10 value of -7 °C. For the new V8880-80 compound, the TR10 value of -29 °C thus far achieved by the V8802-80 Parker compound could even be lowered to -39 °C.

Media compatibility

The media compatibility assessment was performed using various types of fuel mixtures (see Table 2) and simulating various amounts of bioethanol in the fuel mix. The test fuels were mixed according to ASTM D 471 (Fuel C and FAM B). Fuel C in the simulation acts as a standard petrol fuel and relatively non-polar medium. The addition of ethanol simulates the addition of bioethanol to the fuel composition and adds a polar component to the fuel pool which in turn challenges the media compatibility of the test compounds. FAM B is a well-known ASTM test fuel and considered one of the most demanding simulation fuels when testing biofuel compatibility.

With the **V8890-80 FKM** compound a significant increase of bio fuel compatibility combined with a major improvement of cold flexibility could be achieved. The change of volume swell with V8890-80 after completion of the immersion tests (70 hrs / 60 °C) is on a similar level as that of the highly fluorinated FKM V8684-75, irrespective of the amount of bioethanol contained in the fuel mix, thus clearly demonstrating the outstanding flexfuel capability of V8890-80 (see Fig. 3). **V8880-80** with a TR10 value of -39 °C exhibits even better cold flexibility while surpassing current FKM compound solutions such as V8802-80 in terms of biofuel compatibility.

	Fuel C	CE10	CE22	CE85	Ethanol	FAM B	FAM A
Isooctane	50.0						30.0
Toluene	50.0						50.0
Ethanol		15.0	22.0	85.0	100.0		5.0
Diisobutylene							5.0
Methanol						15.0	
Deionisied Water						0.5	
FAM A						84.5	
Fuel C		85.0	78.0	15.0			

Table 2: Overview of test fuel compositions

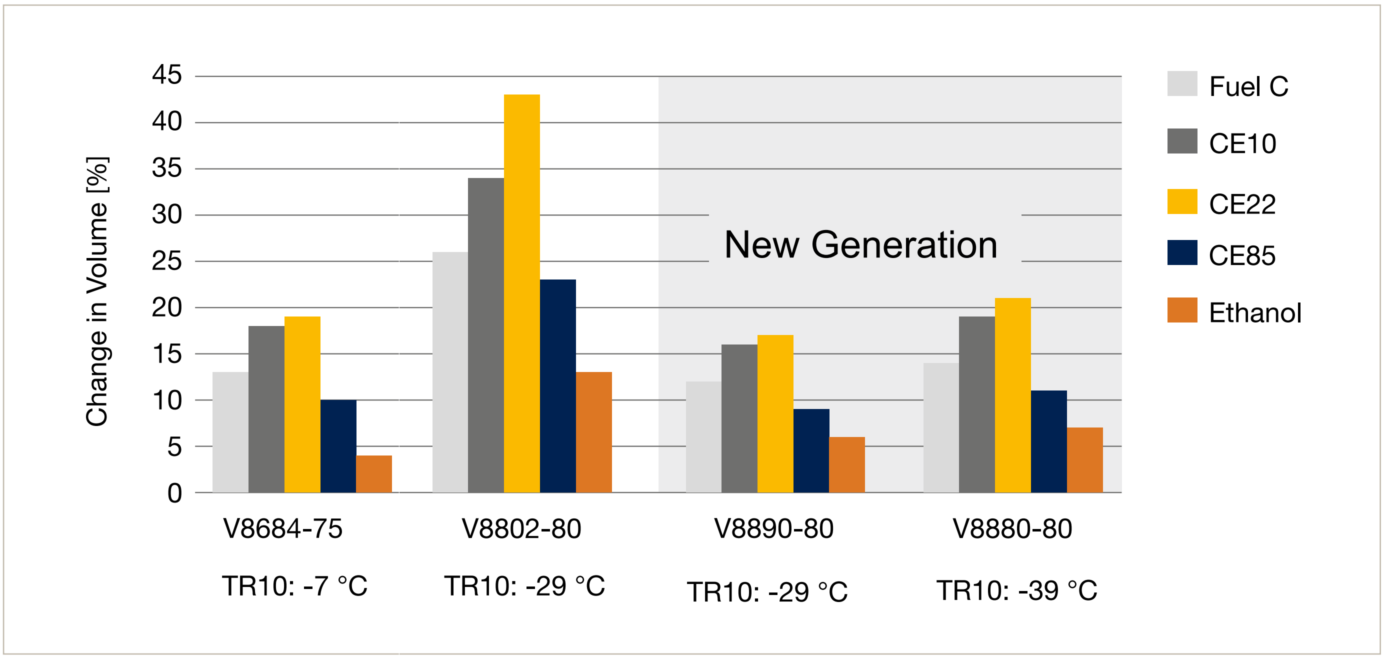

Fig. 3: Graphic representation of the change in volume swell of the compounds subjected to the immersion test (70 hrs / 60 °C) in Fuel C

Subsequently, a further evaluation of the biofuel compatibility of the new material solutions described in this article was performed under even more severe conditions in immersion tests in FAM B for 70 hours at 60 °C (Fig. 4). It should be noted that the increased severity of the conditions resulting from the addition of methanol to the test fuel composition in FAM B is considered a worst-case scenario assessment.

This test, as well, revealed that V8890-80 exhibits biofuel compatibility matching the excellent level of Parker's V8684-75 compound. V8880-80 shows a significant improvement of biofuel compatibility compared with V8802-80 in combination with clearly enhanced cold flexibility.

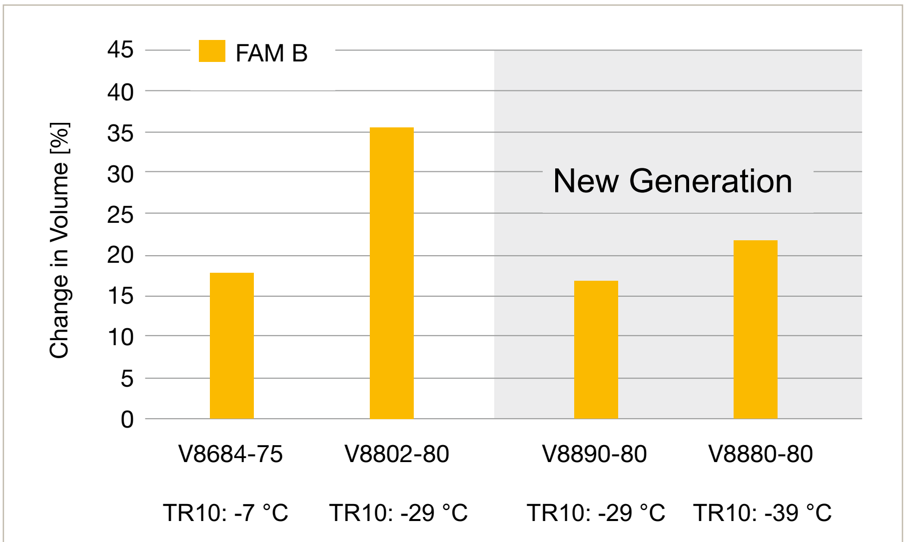

Fig. 4: Graphic representation of the change in volume swell of the compounds subjected to the immersion test (70 hrs / 60 °C) in FAM B.

Perfectly set for new-generation engines

With the new generation of the V8890-80 FKM compound Parker-Prädifa has developed a material solution that combines very good cold flexibility (TR10: -29 °C) with excellent biofuel (bioethanol) compatibility at a level previously reached only by highly fluorinated FKM compounds such as Parker's V8684-75 compound.
Excellent ultra-low-temperature flexibility with a TR10 value of -39 °C was achieved with the new V8880-80 FKM compound, which also surpasses current FKM material solutions such as V8802-80 with respect to media compatibility (bioethanol). Both new compounds are thus fully compatible with flexfuel (FFV) applications, i.e. with vehicles that can be operated with petrol and the alcohols methanol and ethanol or mixtures of both. Consequently, the new compounds are perfectly set for applications in the challenging environments of new eco-friendly engine generations.

Pressure, temperature and permeation

Sealing challenges of hydrogen tank systems

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Increasingly scarce resources and the growing environmental burden caused by conventional motor vehicles require intensified efforts to be made in the development of zero-emissions mobility. The fuel cell and hydrogen as achemical form of energy storage can play an important part in producing electrical energy to propel vehicles. The system pressures generated in the process as well as hydrogen as the medium against which sealing is required confront sealing technology with new challenges in terms of engineering design and compound technology. The following article takes a closer look at them.

Current developments show that the gaseous storage of hydrogen in tank systems up to 350 bar can be reliably and safely controlled from an engineering standpoint. But before fuel cell vehicles can provide a viable alternative to conventional vehicles the system pressure has to be brought up to higher levels to ensure that fuel cell vehicles can achieve a range equivalent to their conventional counterparts. Tanks with a rated system pressure of 700 bar are required for a fuel cell vehicle to achieve a range of approximately 600 km. These high pressures and hydrogen as the medium against which sealing is required confront sealing technology with new challenges regarding the design of the sealing elements and the material properties of the compounds.

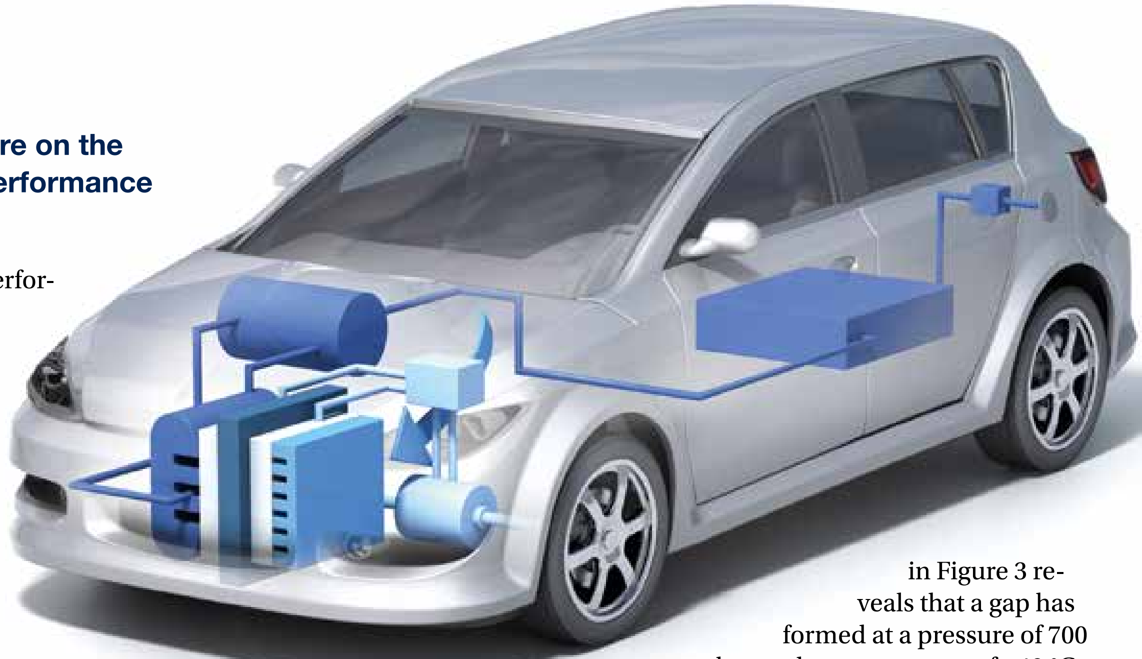
Challenge: pressure and temperature

The specific properties of hydrogen make special demands on the capabilities of elastomeric materials with respect to their suitability as sealing compounds. Apart from the very high pressure the temperatures that are generated play a particularly crucial role in the selection of a suitable sealing material. An important criterion to be considered in the design of hydrogen tank systems with a system pressure of 700 bar is filling the vehicle's tank with hydrogen within a user-friendly time span. As hydrogen heats up in the process of expanding the gas has to be made available at the filling station at a temperature of -40 °C to achieve a refuelling time of 3 minutes. This is contrasted by the demand for increasingly higher service temperatures made on vehicle components. The materials have to be able to cover this large temperature difference. As hydrogen leaks pose a safety risk only extremely minimal leakage may be tolerated in the design of the sealing systems. In addition to primary leakage along the sealing areas, secondary leakage in the form of permeation through the sealing material has to be considered as well.

Challenge: permeation

Permeation refers to the migration of an applied medium through a material. In addition to permeation, due to the small size of the hydrogen molecules, incorporation in the material plays a crucial role as well. The associated swelling can have a decisive influence on the design of the seal. Current research projects are aimed at investigating hydrogen swelling of elastomers. When hydrogen is incorporated into the sealing compound a rapid pressure drop will lead to a sudden volume expansion of the incorporated hydrogen. If the gas cannot escape from the material fast enough or the tensile strength of the material is too low this may lead to the destruction of the material. The suitability of the materials with respect to this so-called explosive decompression has to be assessed as well when selecting the sealing material.

Influence of pressure on the low-temperature performance of elastomers



The low-temperature performance of elastomers is described by the glass transition temperature T_g. This is the temperature at which the material changes from the rubber-elastic to a glass-like brittle state, which results in the loss of the material's sealing-relevant elastic properties. The glass transition temperature is a unique, material-dependent number which is pressure-dependent though. The correlation between the applied pressure and the glass transition temperature will be demonstrated below using the example of an O-ring in a typical hydrogen refuelling event.

The O-ring made from EPDM (ethylene-propylene-dien-rubber) with a glass transition temperature of T_g = -52 °C seals hydrogen with 700 bar at the inner diameter against the environment. In the calculation performed by means of Finite Elements Analysis (FEA) the pressure is continually raised up to 700 bar with the temperature being simultaneously decreased from room temperature to -40 °C. The figures below show the performance of the O-ring in various load conditions. Figure 2 depicts the compression on the sealing area while pressure rises and temperature drops. The enlarged view depicted in Figure 3 reveals that a gap has formed at a pressure of 700 bar and a temperature of -40 °C. This can be explained by the fact that the glass transition temperature has shifted due to the high pressure and the associated compressibility of the sealing material. This would suggest that sealing performance increasingly improves as gas pressure rises. While this is principally true, the effect is only limited. In the event that a very low temperature occurs in addition to a high system pressure this principle may even be reversed. If, for example, an elastomer with good low-temperature flexibility (e.g. $T_g \approx$ -50 °C) is used for sealing gaseous hydrogen under high pressures the T_g value (or the TR10 value which may be used as orientation for the low-temperature performance of a sealing material) exhibits a remarkable behaviour. The T_g value rises and at pressures around 1000 bar may shift upwards by approximately 20 K to 30 K. This may mean that such a sealing material has reached the effective glass transition point at only -30 °C.

At the same time, there are other properties of elastomers that show characteristic changes. For example, the incompressible behaviour of elastomers that exists under normal conditions is replaced by compressible deformation behaviour and a volume decrease occurs with rising system pressure. As a result, a traditionally well-suited low-temperature sealing material may already show leakage at temperatures between -30 °C and -40 °C. Figure 2 depicts the development of the sealing compression of an axially sealing O-ring ▶

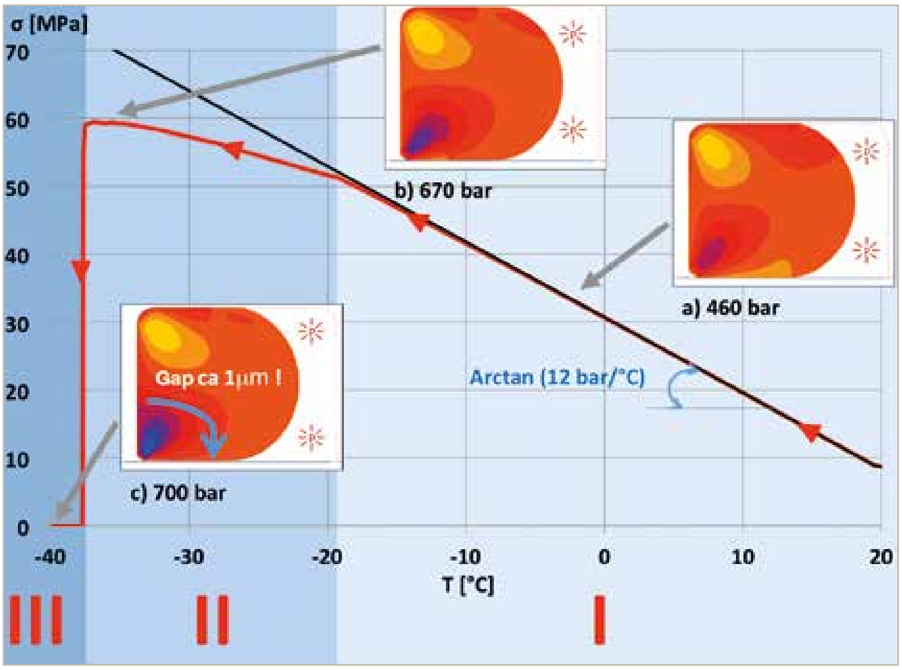


Figure 2: Sealing pressure in the lower sealing area and stress distribution in the O-ring cross-section

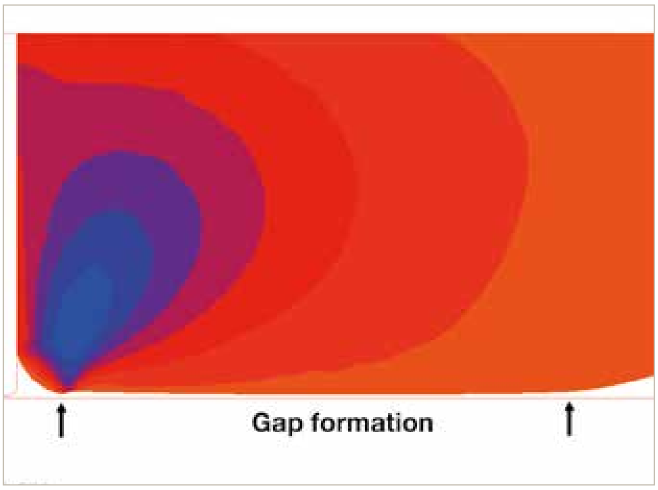


Figure 3: Gap formation between the O-ring and the bottom of the groove

a) Frozen TPU O-ring b) Thawed TPU O-ring

Figure 4: Hydrogen flange with TPU O-ring installed on the outside face

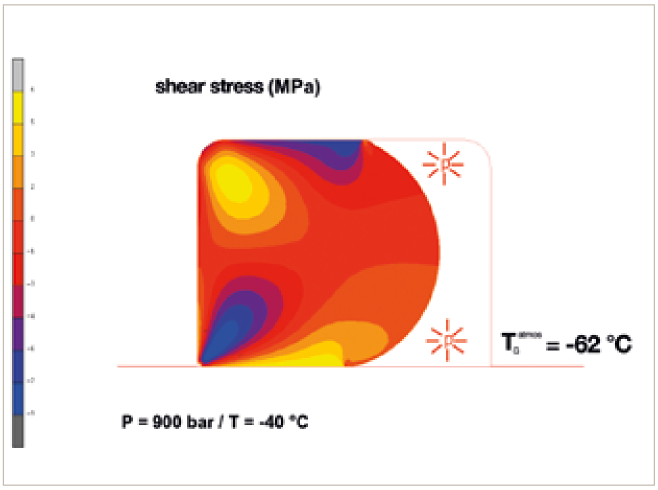


Figure 5: Stress distribution in the cross-section

when in parallel to steadily rising system pressure temperature is lowered. Here, the resulting sealing compression has been plotted above the temperature (red curve): three zones (I, II, III), each with characteristic curves, can be recognised. Based on the atmospheric pressure a sealing compression of approximately 8 MPa is achieved at room temperature. During the process of filling the tank the sealing pressure is steadily increased (Zone I) under rising pressure and with a simultaneous decrease of temperature. The increase corresponds to an overlapping of the system pressure with the sealing compression that already existed at the beginning of the filling event. This strict proportionality ends at approximately -20 °C and a steadily increasing deviation of the seal compression curve from the extrapolated straight of the system pressure occurs. In this phase the system pressure (hydrogen pressure) works on the elastomeric seal, which leads to the so-called volume dilatation – the seal volume decreases. Now, only a minor portion of the additionally applied pressure still benefits the sealing compression (Phase II). This proportion becomes smaller and smaller until ultimately at around -38 °C any further pressure increase is fully converted into a volume change – which in the end leads to a fully formed gap at the sealing area and is tantamount to leakage (Phase III). The pictures introduced in Figure 2 with the stress distribution existing in the respective O-ring cross-section illustrate the beginning of a gap formation which ultimately leads to leakage. As a matter of exception, shear stress is shown here instead of the usual axial stress. Shear stress remains constant when a seal is chambered in its groove in such a way that no additional deformations are possible. This behaviour already occurs under moderate gas pressures. As pressure continues to rise (Phase I) the distribution of the shearing stress in the O-ring cross-section initially remains unchanged. The situation only changes when high pressure and low temperatures make the sealing material compressible. In this state, a volume decrease occurs as well as, indirectly, a change in shear stress distribution (deviatory stress condition; compare a with b in Figure 2). The difference is not very large but significant enough and indicates additional deformation possibilities on the O-ring which initially lead to the formation of a gap both at the bottom of the groove and at the opposite sealing area. Growth towards the bottom is more pronounced as pressure rises. Ultimately, the seal as a whole will be pushed upwards and thus closes the gap again at the top while accordingly the gap is enlarged at the bottom. Figure 4 effectively illustrates this freezing of an elastomeric material. A hydrogen pipeline sealed under high pressure with an O-ring is cooled down to -40 °C. After a fast pressure drop the flange connection is opened and the performance of the O-ring observed. It is clearly discernible that the O-ring in Figure 4a has completely lost its elastic behaviour and remains in its frozen state. As this is a reversible process the O-ring, after

heating above the glass transition temperature, returns to its original geometry (Figure 4b).
The pressure dependency of the glass transition temperature exhibited here is a material-independent quantity and amounts to approximately 0.02 to 0.03 K/bar [1]. This means that at 1000 bar the glass transition temperature shifts by +20 K to +30 K. To confirm this assumption, a further calculation was performed with an O-ring made of a fictitious elastomer with an assumed glass transition temperature of T_g = -62 °C. The results are shown in Figure 5. Even at a pressure of 900 bar and a temperature of -40 °C the glass transition temperature has not been reached in the entire cross-section. There is no gap formation and the O-ring can perform the required function.

Results and outlook

The results and experiences gathered thus far in the development of seals for hydrogen fuel tank systems show that the low-temperature properties of the elastomers are the decisive factor for safe and reliable sealing of hydrogen. Current projects are aimed at developing compounds with very low permeation combined with a very low T_g value of below -80 °C in order to meet the demands of these issues. For use in hydrogen tank systems Parker recommends various materials with outstanding low-temperature properties such as TPU P5009, EPDM E0540 and the chlorobutyl rubber B8885. Apart from their low-temperature properties, these compounds are characterised by very low permeation with hydrogen as well as a low explosive decompression tendency. An important aspect for the approval of hydrogen-operated vehicles in the European Union is the certification of the materials according to Regulation EC 79/2009. ■

Compound	B8885	P5009	V9145	E0540
Elastomer base	CIIR	TPU	FKM	EPDM
Permeation	++	+	+	O
Low-temperature properties	++	+	O	+
Swelling under H_2-atmosphere	++	++	+	+
Explosive decompression	+	++	+	+
Extrusion resistance	O	++	++	+
High-temperature suitability	++	O	++	+

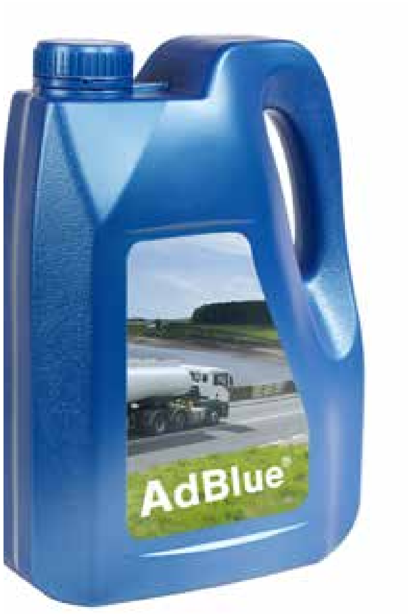
[1] Achenbach, M.; Albrecht, D.; Sealing upon high Pressure and low Temperature; 17th International Sealing Conference, Stuttgart, 2012

Promoting Elastomer Research

Dr. Manfred Achenbach appointed to DKG research council again

February 2013. The "Deutsche Kautschuk-Gesellschaft e.V." (German Rubber Society, Inc.) has appointed Dr Manfred Achenbach, Head of Technical and Analytical Services of the Parker Packing Division Europe, for a fourth term – from 2013 to 2016 – as a member of its research council.

The DKG is an alliance of over 1,000 personal and corporate members who pursue the aim of promoting research and development in the field of elastomers and promulgating the knowledge gained in this area of expertise.
The DKG organises numerous conventions and congresses to foster active and fruitful professional exchanges, promotes and funds rubber research at universities and institutes, and supports the publication of the results in expert meetings and in trade magazines. ■



High performance at high temperatures

New compound solution for AdBlue® injectors

Like cars with petrol engines diesel-powered vehicles have been subject to compliance with increasingly more stringent emission standards in recent years as well. The use of AdBlue®, primarily for trucks but showing a growing trend with passenger cars too, plays an important part in this context. Therefore, Parker started to develop AdBlue®-compatible sealing materials early on. Specifically for the high temperatures in AdBlue® injector systems a new material, HNBR type N8909-75, has now been added to the portfolio. Compared with the current compounds – both the standard HNBR and the standard EPDM types – it exhibits significantly improved media resistance and thus swelling performance in the high-temperature range.

Dr Heinz-Christian Rost
Technology and Innovation Manager
O-Ring Division Europe

AdBlue® is the brand name (the brand rights are held by the VDA) of a synthetically produced aqueous urea solution which after conversion into ammonia in the SCR (= selective catalytic reduction) catalytic converters of modern diesel vehicles primarily serves to reduce nitrogen oxides (NOx). However, by improving combustion of the fuel in the engine it indirectly leads to a reduction of particulate as well and can even help to reduce fuel consumption by eliminating the need for exhaust gas recirculation (EGR).

In the selective catalytic reduction process the nitrogen oxides contained in the exhaust gas are "selectively", i.e. preferentially, reduced in an oxidation catalytic converter downstream of the SCR catalytic converter. This occurs through a chemical reaction of the exhaust gas with ammonia injected in the form of the 32.5-per cent AdBlue® urea solution upstream of the SCR catalytic converter from a separate tank. In a hydrolytic reaction in the exhaust system ammonia is released from AdBlue® and subsequently reacts with the nitrogen oxides into nitrogen and hydrogen – two substances which are harmless from an environmental perspective. This can reduce the nitrogen oxides in the exhaust gas by as much as 80 % or even more.

Well-balanced material properties profile

As a sealing solution for aqueous systems such as AdBlue® the two material groups EPDM or HNBR are used which due to their chemical structure exhibit good media compatibility in the application environment. Table 1 shows an overview of the physical properties of Parker's E8556-70 EPDM standard compound and N3831-70 HNBR compound plus the material data of the new N8909-75 type developed specifically for AdBlue® injectors.

Test	Standard	Dimension	E8556	N3831	N8909
Elastomer base			EPDM	HNBR	HNBR
Colour			black	black	black
Hardness	DIN 53505	Shore A	71	75	75
Tensile strength	DIN 53504	N/mm^2	17.4	24.8	26.0
Ultimate elongation	DIN 53504	%	243	303	311
Modulus (100 %)	DIN 53504	N/mm^2	5.1	6.4	6.4
Low temperature properties TR10	ASTM D 1329	°C	-44	-17	-8

Table 1: Comparison of the physical properties of the EPDM and HNBR types

Test	Standard	Dimension	AdBlue® 168 h / 80 °C	AdBlue® 168 h / 100 °C	AdBlue® 168 h / 120 °C
EPDM E8556-70					
Change in hardness	DIN 53505	Shore A	0	0	-4
Change in tensile strength	DIN 53504	%	+1	+1	-3
Change in ultimate elongation	DIN 53504	%	+2	+2	-14
Change in volume	ASTM D 1329	%	+1.4	+0.6	+46.6
HNBR N3831-70					
Change in hardness	DIN 53505	Shore A	-5	-6	-11
Change in tensile strength	DIN 53504	%	+1	-1	-1
Change in ultimate elongation	DIN 53504	%	+2	-15	+3
Change in volume	ASTM D 1329	%	+3.7	+20.3	+33.2

Table 2: Influence of the test temperature on the properties profile of standard EPDM and HNBR

E8556-70 exhibits a well-balanced material profile. The same is the case with the two HNBR formulations that show slightly higher tensile strength along with improved elongation at break. The low-temperature flexibility of the HNBR types is well suited for static sealing of AdBlue® systems whose freezing point is at -11 °C.

Chemical attack at high temperatures

During the injection of the AdBlue® solution into the exhaust gas stream temperatures in the injectors rise to more than 100 °C. Due to the elevated temperatures an increased amount of ammonia is generated as a by-product. This increases the demands made on the media resistance of the sealing materials. Furthermore, at temperatures of up to 120 °C (short-term 150 °C) improved media resistance to hot water and exhaust gas condensates has to be assured as well. In the case of EPDM and standard HNBR types the ammonia being generated at elevated temperatures of 100 °C and 120 °C leads to significantly higher volume swell (see Table 2).

Therefore, Parker-Prädifa has developed a new HNBR type for AdBlue® applications in the high-temperature range that exhibits significantly lower volume swell while showing comparable material characteristics. Figure 1 summarises the comparison results of the AdBlue® ageing tests at 120 °C for 168 hours.

The significant reduction in volume swell with N8909-75 can be clearly recognised. Here, a relative improvement of more than 60 % was achieved. The changes in hardness and tensile strength match the known, very good performance level of the N3891-70 standard material. A minor variance of the property change was only observed in the case of elongation at break.

Compound solution for "hot" requirements

Parker-Prädifa has developed the N8909-75 HNBR compound type as a material solution specifically for high-temperature AdBlue® applications.
It is characterised by significantly improved swell performance at temperatures above 100 °C, which makes this sealing material well suited for use in the "hot" ambient application environment of AdBlue® injector systems.

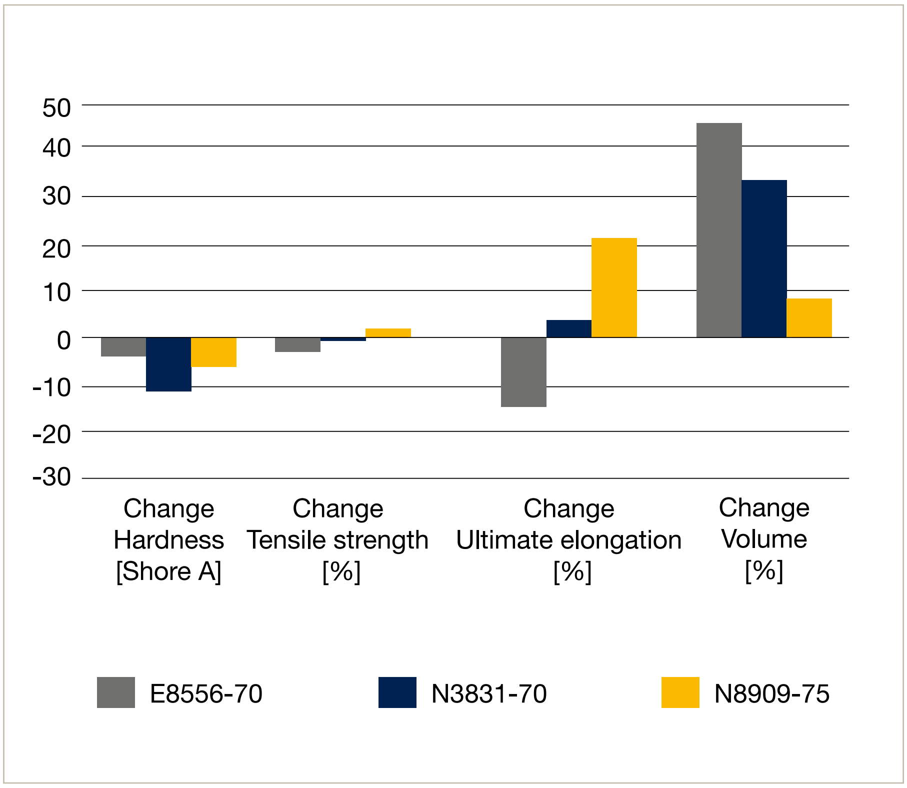


Figure 1: Comparison of the immersion results obtained in AdBlue® ageing tests run for 168 hours at 120 °C

Resistance specialist

Material solution for acidic environments in EGR systems

Dr Heinz-Christian Rost,
Technology and Innovation Manager,
O-Ring Division Europe

Along with the steadily rising efficiency of new engine generations the challenges posed to the seals used in modern engine environments increase as well. Highly acidic by-products, for example, are generated in the intake and exhaust gas recirculation (EGR) systems, requiring sealing solutions that withstand such harsh conditions. Parker-Prädifa offers V8892-70 as a solution which is characterised by substantially improved acid resistance compared to today's standard FKM compounds.

Efficiency improvements of modern passenger car and truck engines combined with lower emissions are among the key product strategies of automotive OEMs. Downsizing of internal combustion engines and use of advanced exhaust gas aftertreatment systems such as exhaust gas recirculation (EGR) have proved to be viable means of complying with stringent carbon dioxide emission standards established by legislators. The inclusion of biofuels in the fuel mix makes a further contribution to reducing the environmental burden caused by motor vehicles.

New chemical conditions

The introduction of these advanced technologies is changing the chemical environment within the engine as they cause highly acidic by-products to be generated. The use of low-pressure EGR systems cools the exhaust gas down to temperatures below the dew point (80 to 140 °C). By-products of the combustion process such as sulphuric acid and hydrochloric acid are enriched in the water during the combustion process and leave the engine via the exhaust system.
This leads to the formation of acidic condensates, i.e. components which downstream of the EGR cooler can cause heavy corrosion and thus severely damage if not destroy components unless they are made from high-performance materials[1)].

Test	Standard	Dimension	V8892-70
Elastomer base			FKM
Colour			black
Hardness	DIN 53505	Shore A	70
Tensile strength	DIN 53504	N/mm^2	15
Ultimate elongation	DIN 53504	%	284
Modulus (100 %)	DIN 53504	N/mm^2	4.9
Low temperature properties TR10	ASTM D 1329	°C	-17
Compression set (70 h / 200 °C)	DIN ISO 815	%	18

Table 1: Physical properties of the FKM compound V8892-70

[1)] M. Fasold, D. Traichel, United States Patent 8272371, Device and method for neutralizing acidic condensate in a motor vehicle, granted 25th of September 2012.

The acid-resistant V8892-70 FKM compound by Parker-Prädifa is an excellent choice when it comes to achieving outstanding sealing performance in acidic application conditions. V8892-70 combines strong elastic properties with excellent compression set at high temperatures plus good cold flexibility. The material properties of this compound solution are summarised in Table 1.

Survival artist in acidic environments

The V8892-70 FKM compound has been specifically developed for excellent performance in acidic environments. A comparison of the properties of this material with a state-of-the-art standard FKM compound following an immersion test in acetic acid at 100 °C for 168 hours shows that with V8892-70 a significant improvement of acid compatibility has been achieved (Figure 1).

Compared with the standard FKM only a marginal change of hardness and tensile strength was observed in the case of V8892-70. The strategy that was used for the compound formulation made it possible to reduce relative volume swell by as much as 69 %, resulting in a volume change of merely 4 % with V8892-70 after the test, whereas volume swell of a standard FKM amounted to 29 %.
These excellent results were mirrored by the performance assessment of V8892-70 in other demanding media. Figure 2 depicts the changes in material properties after subjecting the test specimens to hydrochloric acid (1M) for 168 hours at 100 °C. Again, a merely marginal change in hardness, tensile strength and volume change was noted.

A long-term test in sulphuric acid with a pH value = 2 for 504 hours at 100 °C underlines the outstanding properties profile of the acid-resistant Parker FKM compound. Again, V8892-70 exhibited outstanding performance with insignificant changes in the material properties.

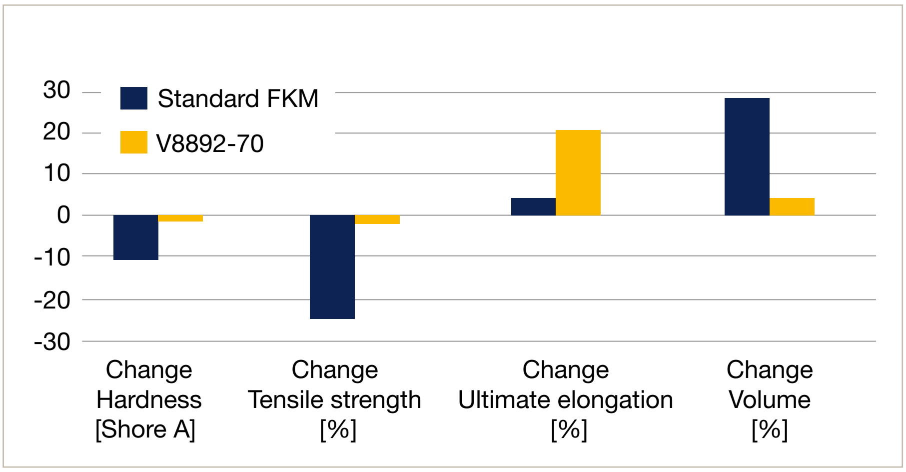


Figure 1: Comparison of the material properties of a standard FKM with V8892-70

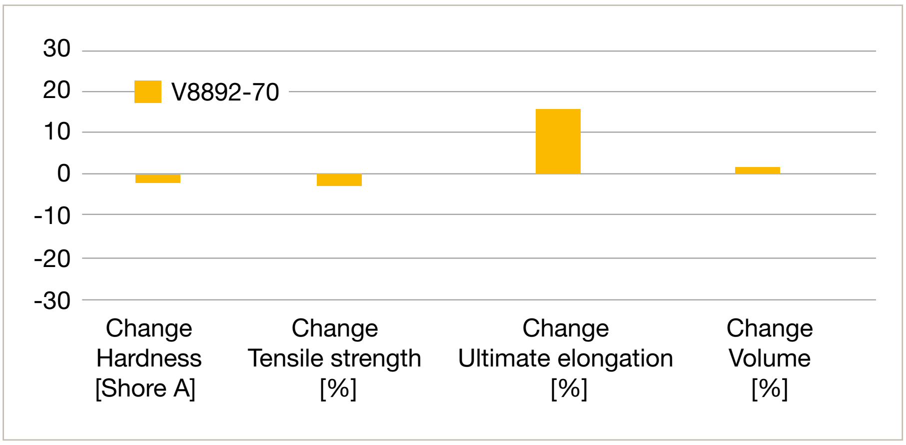


Figure 2: Immersion test in hydrochloric acid (1M) at 168 hours / 100 °C

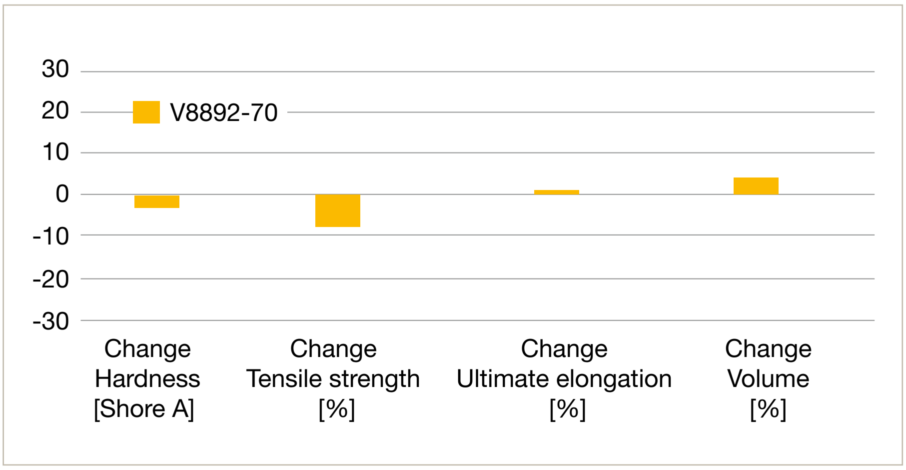


Fig. 3: Long-term test in sulfuric acid pH=2 (504 h / 100 °C)

Compound solution for challenging conditions

Parker-Prädifa's V8892-70 FKM compound offers excellent elastic properties combined with outstanding high-temperature compression set and good cold flexibility. Thanks to merely minimal changes in material performance even in severe acidic ambient conditions at elevated temperatures for prolonged periods of time V8892-70 is the solution of choice for challenging applications in the intake and EGR systems of internal combustion engines.

Bye-bye blow-by

Material solution for aggressive gases and condensates

Dr Heinz-Christian Rost
Technology and Innovation Manager
O-Ring Division Europe

Blow-by gases and condensates generated in the operation of internal combustion engines pose a major challenge to sealing materials. Blow-by fluids typically contain acidic components and are thus chemically aggressive. The Parker V8722-75 FKM compound has been specifically developed for outstanding resistance in these application conditions. Proof that the material lives up to its promise was provided by validation testing with standardised blow-by condensates according to BMW specification. V8722-75 exhibited a very minor change in mechanical properties and volume swell compared to the V0747-75 standard FKM. It thus provides an excellent solution for aggressive gases and condensates.

The issue of blow-by fluids in modern internal combustion engines is related to the reduction of harmful emissions. Simply put, to reduce emissions, smaller amounts of exhaust gas and unburned fuel are recirculated into the combustion chamber. This so-called "blow-by" can enter the crankcase where it can produce condensates if ventilation is insufficient. As blow-by fluids typically contain acidic components they pose a serious threat to sealing materials even if the compounds, such as standard fluoroelastomers (FKM), are generally regarded as being chemically rather robust.
The new blow-by-resistant Parker-Prädifa FKM V8722-75 compound successfully meets this challenge. The resulting sealing solution offers an excellent material properties profile and, in addition, is characterised by outstanding functional performance in blow-by areas.

Table 1 compares the properties profiles of the Parker standard FKM V0747-75 compound and the new-generation V8722-75. With good cold flexibility, i.e. a TR10 value of -17 °C, V8722-75 can be used in a wide range of sealing applications at low temperatures. Very good elastic properties plus very good compression set at high temperatures complement the performance profile of this new material solution.

Standardized blow-by test validates excellent performance

The performance of V8722-75 was demonstrated in a test with blow-by simulation fluids according to BMW Test Specification GS 97018 : 2011-11. The composition of the respective test fluids was as follows:

BMW Condensate I:
- 1.00 weight per cent naphthalene
- 44.50 weight per cent FAM A (acc. to DIN 51604-1)
- 44.50 weight per cent Cecillia 20 BP reference oil
- 10.00 weight per cent formaldehyde: 10 % (stabilised with 10% methanol)

→ FAM A = isooctane (30 parts), toluene (50 parts), ethanol (5 parts), diisobutylene (15 parts)

BMW Condensate II:
- 10.00 weight per cent formaldehyde: 10 % (stabilised with 10 % methanol)
- 89.70 weight per cent de-ionised water
- 0.18 weight per cent HNO_3 (65 %)
- 0.06 weight per cent formic acid (98-100 %)
- 0.06 weight per cent acetic acid (96 %)

All tests were performed in pressure vessels for 72 hours at 120 °C.

The BMW Condensate I, which contains oil, poses a two-fold challenge to the material. On the one hand good compatibility with non-polar media such as oil is required here and on the other resistance to media such as formaldehyde, methanol and ethanol which tend to be on the polar side.

As shown in Figure 1, with V8722-75 improvements were achieved with respect to elastic properties as well as volume swell. V8722-75 primarily exhibited a much greater improvement in performance with respect to elastic properties under the given test conditions.

BMW Condensate II is even more challenging. The combination of various acids pushes conventional standard FKM compounds such as V0747-75 to their limits. The results in Figure 2 clearly show the degradation of V0747-75 under these more severe conditions. Due to massive volume swelling of 230 % the hardness of the test specimens could no longer be measured after the test.

V8722-75 thus elevates media compatibility under the given conditions to a new level. By using an advanced compound formulation strategy a relative reduction of 75 % in volume swell was achieved, with only marginal changes in hardness and elastic properties.

The compound of choice for aggressive environments

Through the development of the new V8722-75 compound for blow-by applications Parker-Prädifa offers an excellent solution for sealing requirements in the challenging, aggressive environment of internal combustion engines that sets new standards in this area of sealing applications.

Test	Standard	Dimension	V0747-70	V8722-75
Elastomer base			FKM	FKM
Colour			black	black
Hardness	DIN 53505	Shore A	75	75
Tensile strength	DIN 53504	N/mm²	14.5	17.5
Ultimate elongation	DIN 53504	%	195	195
Modulus (100 %)	DIN 53504	N/mm²	5.9	7.4
Low temperature properties TR10	ASTM D 1329	°C	-15	-17
Compression set (70 h / 200 °C)	DIN ISO 815	%	18	20

Table 1: Comparison of the physical properties of FKM V0747-75 and V8722-75

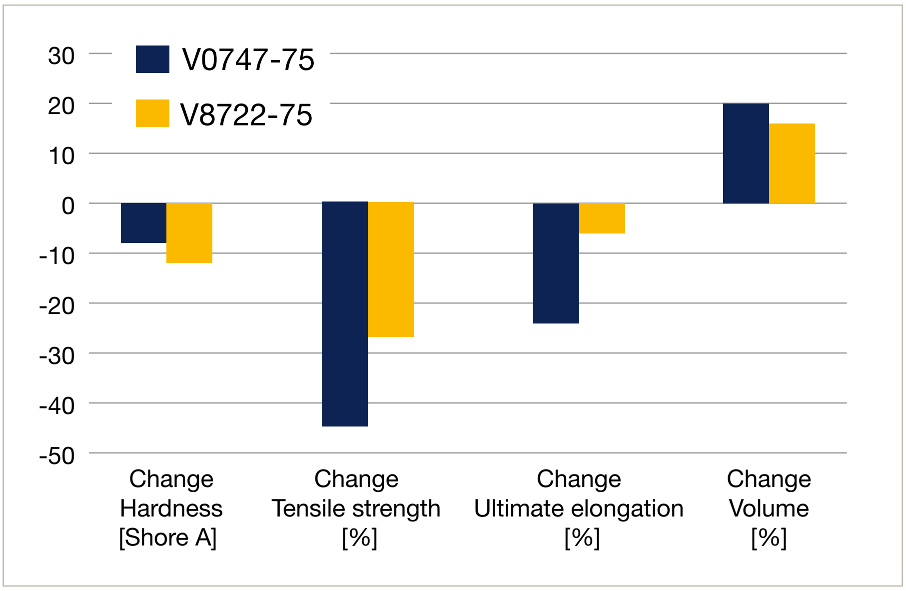


Figure 1: Comparison between V747-75 and V8722-75 in the test with BMW Condensate 1

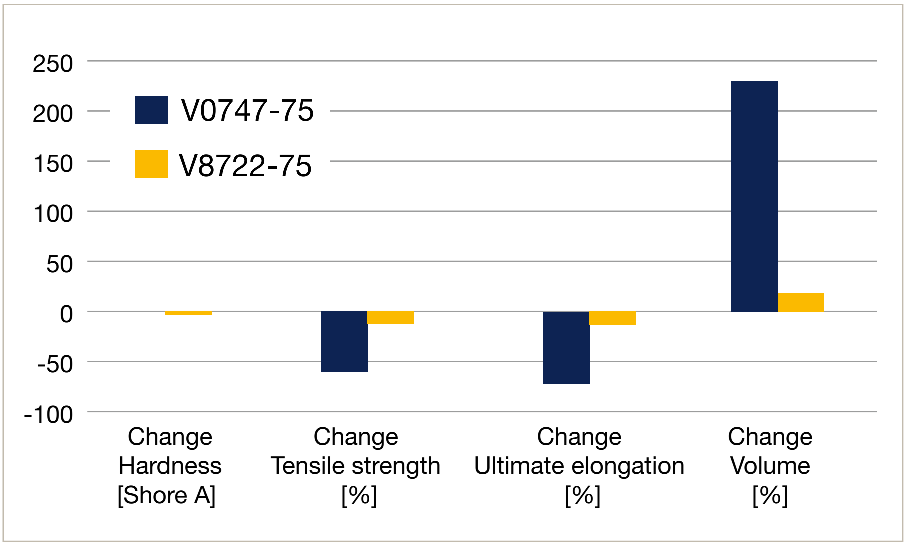


Figure 2: Comparison between V0747-75 and V8722-75 in the test with BMW Condensate 2

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