Parker Prädifa

ENGINEERING YOUR SUCCESS.

June 2017

EMG report

Magazine for Customers of the Engineered Materials Group Europe

Materials for Use in the Chemical Process, Pharma and Food Industries 6

XXL-Size Seals and Molded Parts 22

Innovative Multi-Component Technology for Sealing Elements and Engineered Components 36

News from Parker Prädifa – Our Highlights from the 2017 Hanover Fair

Dear customers and business partners,
Dear trade fair guests,

The 2017 Hanover Fair took place several weeks ago and was a resounding success for Parker Prädifa. Once again, we were overwhelmed by the tremendous response and wide-ranging interest in our technology, product development, purchasing and logistics topics, our materials engineering and product development highlights, and our sealing technology innovations we presented to you in Hanover. Therefore, we would like to take this opportunity to sincerely thank you again for your visit, your interest and the many stimulating discussions we were able to have with you in Hanover.

At our trade fair stand, you had the opportunity to gain a personal impression of our current product and service portfolio which, in addition to our extensive range of sealing and compound solutions for "classic" fluid power and many other industrial applications, is specifically focused on sensitive production processes in the food, pharmaceutical and drinking water, biotech and medical device technology sectors, particularly featuring new, ultra-pure compounds and PAH-free materials with respective approvals and conformances. In this context, and in response to the wishes of many users, we are now complementing the nobrox® compound family we previously introduced to you at the 2015 Hanover Fair by an FDA variant as well.

In addition, we were able to present to you in Hanover our all-new XXL-size sealing solutions using elastomers, PTFE and metal as well as multi-component composite parts for diverse industrial applications.

You will find a brief review of the trade fair and more in-depth information in various articles covering all these exciting topics in this issue of our EMG Report. And in case you did not have the opportunity to visit us in Hanover, just follow the link to our video on page 5.

As always, we look forward to successfully responding to your challenging applications with our time-tested solutions as well as our current and future new developments.
In keeping with our promise:

ENGINEERING YOUR SUCCESS.

Sincerely yours,

Jochen Nigge
General Sales Manager EMEA, Engineered Materials Group

Cover Story: Materials for Use in the Chemical Process, Pharma and Food Industries

Top Topics

Materials for Use in the Chemical Process, Pharma and Food Industries 6

XXL-Size Seals and Molded Parts 22

Innovative Multi-Component Technology for Sealing Elements and Engineered Components 36

EMG Report

The "EMG Report" is a magazine for customers of the Engineered Materials Group Europe.

Published by
Parker Hannifin GmbH
Engineered Materials Group Europe
Arnold-Jäger-Str. 1 · 74321 Bietigheim-Bissingen · Germany
Tel. +49 7142 351-440 · Fax +49 7142 351-432
www.parker.com/praedifa · praedifa@parker.com

Editor
Christine Stehmans
Marketing Communications Manager
christine.stehmans@parker.com

Hanover Fair 2017

22 XXL-Size Seals and Molded Parts

28 Single-Use Consumables for Biotechnical Processes

32 New Sealing Solution for Hydraulic Swivel Joints in Mobile Cranes

Contents

Editorial	3
Hanover Fair 2017 – the Highlights	4
Materials for Use in the Chemical Process, Pharma and Food Industries	6
Universal Material nobrox® for Food Applications	10
Pure and Stable Sealing Materials for Use in Modern Kitchen Appliances	14
PAH-Free Sealing Materials	18
XXL-Size Seals and Molded Parts	22
Single-Use Consumables for Biotechnical Processes	28
New Sealing Solution for Hydraulic Swivel Joints in Mobile Cranes	32
Innovative Multi-Component Technology for Sealing Elements and Engineered Components	36
Techniques for Thermal Management of Electronics	38

Hanover Fair 2017

Fluidpower Sealing Solutions

Sealing technology in XXL-sizes

Multi-Component Technology

Manual Dexterity Test Combined with Helping Needy Children

The Parker Engineered Materials Group donated 1 euro per participant to Deutsches Kinderhilfswerk e.V. Berlin and thus supports equal educational opportunities.

Sealing Solutions for Sensitive Production Processes, e.g. for the Food Processing Industry

We invite you to recall your visit to our trade fair stand or – if you didn't have the chance to visit us – to get some impressions of our presentation by watching our video. Learn more about our

- Sealing solutions for sensitive production processes
- Sealing technology in XXL-sizes
- Multi-component composite parts
- Fluid power sealing systems

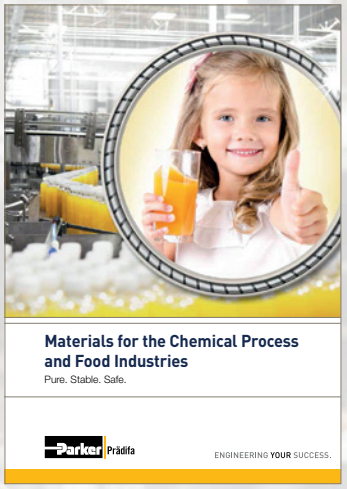
Safety for the Consumer Due To Purity and Stability

Materials for Use in the Chemical Process, Pharma and Food Industries

Author

Christine Stehmans
Marketing Communications Manager,
Engineered Materials Group Europe

The requirements in the chemical and process industries as well as in food/beverage and pharmaceutical production are highly diverse. The wide variety of Parker Prädifa materials and product solutions for sensitive production processes fully covers this diversity, from conventional O-rings through to highly complex system solutions. In spite of their diverse properties, the material and product solutions from Parker Prädifa for these critical applications have one thing in common: they are pure, stable and safe.



A new brochure from Parker Prädifa provides comprehensive information about the various material families for seals and engineered components in the aforementioned industries, their property profiles and applications, plus the national and international standards and regulations on wich the approvals and conformities are based.

Purity and stability of the materials used for the sealing elements and sealing systems in food and pharmaceutical production processes are indispensable prerequisites for the safety of the final products intended for human consumption. As well as industrial production systems, this includes appliances for catering and food service operations, and for domestic use, such as food processors and coffee machines.

Product Safety

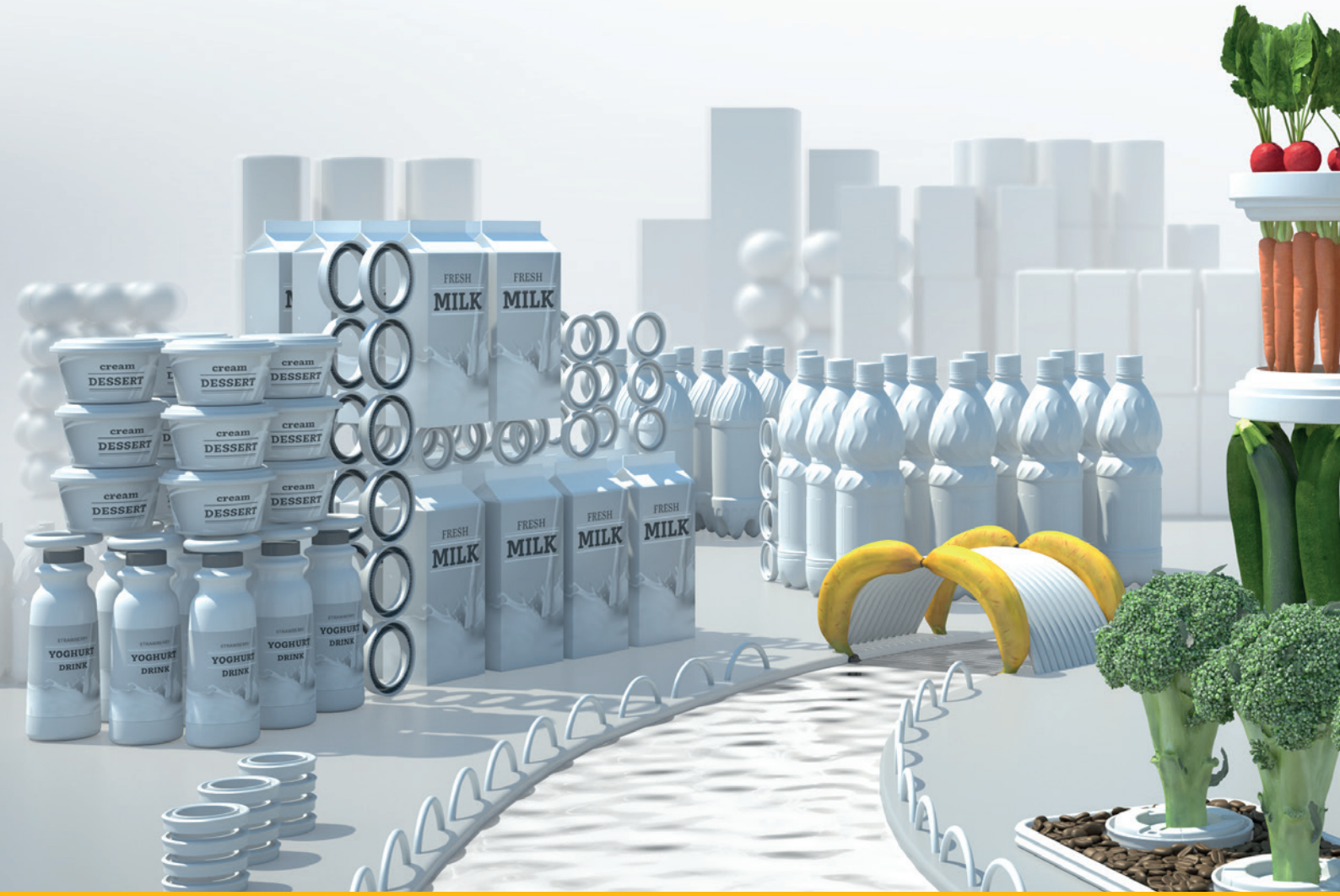
To protect the health of consumers the materials have to comply with specific legal requirements and standards, depending on their application. The harmlessness of the materials for the intended uses, such as applications involving contact with foodstuffs and drinking water, must have been certified by relevant approvals and conformities. Equally important to consumer safety is that the materials are free of polycyclic aromatic hydrocarbons (PAH), phthalates, mineral oil based plasticizers and animal derived ingredients (ADI).
In addition, qualitative aspects such as neutrality with respect to taste and odor generally have to be ensured whenever materials are utilized in food and beverage production. In the production process, the sealing compounds must not release any components which – even if not harmful to human health – would affect the quality of the final product in any way that could be perceived by the senses or otherwise.

Process Diversity

As particularly the processes in the food and beverage sector are as wide and varied as the products themselves they make special demands on the seals and sealing compounds used in them as well – be it in terms of resistance against chemical substances and various process media, temperatures, pressures and mechanical loads or special sanitary requirements. Of particular relevance here are CIP/SIP processes for cleaning and sterilization involving disinfectants, superheated steam and acids. The reliable functionality and durability of the seals has to be ensured even in harsh application conditions.

Material Diversity

This wide range of requirements can only be covered by a wide range of materials and material groups. The appropriate selection from Parker Prädifa's extensive portfolio of sealing compounds is made based on the required properties profile in combination with the necessary approvals and conformities existing for the respective material. With pure to ultra-pure materials optimized for the respective applications in the material groups of EPDM, NBR, FKM, FFKM, TPU, PK, PTFE and metal Parker Prädifa offers precisely this diversity of possible choices and combinations, for example:



EPDM
compounds for highly sensitive production processes in the food and beverage industry, biotechnology and medical device technology
Properties: very good media resistance in hot water, steam, lyes and acids, in polar CIP/SIP media and resulting long life even in cleaning and sterilization processes
Approvals/conformities: FDA, USP Class VI, 3A, (EC) No. 1935/2004

EPDM
compounds for drinking water applications
Properties: very good mechanical properties, outstanding compression set, good low-temperature performance down to -50 °C
Approvals/conformities: FDA, WRAS, W270

NBR
compounds for food applications
Properties: very good media resistance in media containing oil and grease, very good wear resistance
Approvals/conformities: FDA, (EC) No. 1935/2004.

FKM- und HiFluor®
compounds for the food and beverage industry, biotechnology and medical device technology
Properties: excellent media and temperature resistance
Approvals/conformities: FDA, 3A USP Class VI, (EC) No. 1935/2004, BNIC

Parofluor® FFKM
compounds for the food/beverage and pharmaceutical industries
Properties: pure high-performance compounds with extended service life and suitability for extreme chemical and thermal requirements
Approvals/conformities: FDA, (EC) No. 1935/2004, USP Class VI

Ultrathan® TPU
compounds for food industry applications including food gases and household appliances
Properties: high wear resistance, good hydrolysis resistance and good permeation properties
Approvals/conformities: FDA, (EC) No. 1935/2004.

Polon® PTFE
compounds for the food industry
Properties: best media resistance and widest temperature range, excellent friction behavior
Approvals/conformities: FDA, (EC) No. 1935/2004, USP Class VI.

PK compound nobrox®
for sealing elements and other engineered components in the food industry
Properties: outstanding wear resistance, chemical resistance and resilience
Approvals/conformities: FDA, (EC) No. 1935/2004, USP Class VI.

Metal
seals for harsh application conditions, outside the application range of polymer materials. ■

Universal Material no

Authors:

Matthias Buchfink
Application Engineering,
Prädifa Technology Division

Michael Erwerle
Compound Technology/Test Laboratory,
Prädifa Technology Division

brox® for Food Applications

Compound Versatility Beats Compound Variety

Be it in the food processing industry, restaurants or residential kitchens: components with food contact in industrial equipment and household appliances are subject to strict legal and exacting technical requirements. In W6101, the food variant of the universal material, nobrox®, Parker Prädifa is now offering an alternative to the previous compound variety that covers many demands in the food sector with a single material.

As the variety of food available today keeps increasing, so does the range of kitchen helpers that make cooking easier while enabling new forms of preparing food. There are more and more devices assisting professional chefs as well as the average consumer in preparing meals and beverages. These technical helpers require high-performance materials meeting the needs of a complex media environment and the demands of the market. The same applies to large-scale equipment in industrial food production with processes from which many of the small devices ultimately take their cues.

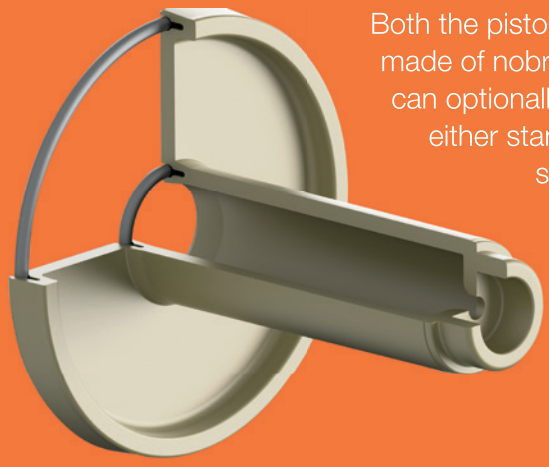
Compound Versatility Beats Compound Variety

Food processing machines increasingly use polymeric components such as tubes, covers or housings – as well as highly stressed engineered elements like seals, wipers, guides and pistons. Materials used in the food sector are subject to specific legal and challenging technical requirements. The utilization of plastic materials as a cost-effective alternative to metal makes sense in many applications as well. Technical requirements in terms of temperature resistance and structural strength can typically be met by selecting appropriate plastics. In addition to cost benefits, this may also yield functional and technical advantages as previously illustrated by the specific example of industrial coffee machines (see April 2015 issue of the EMG Report, page 7).

This is nobrox®

- Suitable for versatile uses
  - In sealing technology: as a sealing element, guiding element, anti-extrusion element, diaphragm, …
  - Outside sealing technology: as a material for engineered components
- Extremely wear-resistant
- Resistant against abrasive particles, rough surfaces, etc.
- Robust and simplified assembly
- High elastic resilience
- Wide media resistance
- Cost-efficient

nobrox® Piston with Integrated Rod and Piston Seal



Both the piston and the seals are made of nobrox®. The sealing lips can optionally be preloaded with either standard O-rings or metal springs. A silicone filling, for instance, is possible in order to avoid dead spaces when using metal springs.

Figure 1

Normally, various tailored materials are used to cover diverse requirements. Each of these materials has to conform to legal and technical requirements, resulting in a high documentation and testing effort. nobrox® offers new opportunities – particularly in the food sector – to meet many of the market-specific challenges and, as a result, to limit the variety of materials needed and the related expense and effort.

Laws, Regulations, Approvals

The extensive legal provisions in the food sector are to be mentioned first in this context. There are rules for documentation, the chemical composition of the compounds, and the way they are processed and handled. In Europe, the European Parliament and Council determine these requirements. Regulations (EC) No. 1935/2004 and (EU) No. 10/2011 describe the demands made on materials and objects intended for contact with foodstuffs. In the United States, the Food and Drug Administration (FDA) is responsible for food safety. FDA approvals are used around the globe. nobrox® W6101 meets the requirements of these institutions as listed below:

- Food Contact Substance Notification (FDA)
- (EC) No. 1935/2004
- (EU) No. 10/2011
- NSF 61 (U.S. drinking water approval)

Chemical Compatibility and Reaction Potential

Foodstuffs are typically aqueous media containing a large number of polar and non-polar substances and chemicals, milk being a simple case in point. Milk is a mixture of polar water and non-polar fat. Both metallic and polymeric materials must be resistant against these media, requiring the utilization of costly stainless steel and special thermoplastics and elastomers. “Similia similibus solvuntur”: “Similar substances will resolve similar substances.” In the case of milk this means that a polar medium like water will resolve a polar polymer such as polyamide or cause it to swell. A non-polar medium like olive oil will attack a non-polar elastomer such as EPDM. Therefore, even the demands a polymer has to meet in terms of basic compatibility with milk are anything but trivial. In addition to the chemical compatibility of the materials used, reactions with foodstuffs must be excluded as well as any change in taste. The exchange of ingredients from the polymer and the foodstuff must be prevented. Migration tests are used to determine to what extent ingredients from the material migrate into foodstuffs and vice versa. Limits specified by the relevant authorities have to be complied with in various food simulants.

Functional Integration and Reduction of Material Variety

Due to its mechanical properties profile, nobrox® can be classified to range between thermoplastic materials such as polyamides and PEEK and their derivatives. However, there are crucial advantages compared with polymeric materials commonly used in the food industry. A substitution of typical materials in the food sector such as PEEK, PA, POM, PTFE, UHMW-PE, TPE-U or various elastomers makes sense and is feasible in a wide application window.
nobrox® is suitable for use in the form of dynamic seals or wipers as well as for a wide range of other engineered parts such as pistons, guides or gearbox components. Functional integration – e.g. the integration of the seal, wiper or guide in a piston – and the related reduction of the number of components is possible as well (figure 1).

Enhanced Hygiene and Ease of Use due to Fewer Components

As the number of components decreases, so do assembly requirements and the cuts and joints of the design, which harbor the greatest risk of contaminations and accumulations of food residues and microorganisms. The typically difficult accessibility of narrow gaps (e.g. in front of seal grooves and butt joints) is reflected in long and costly cleaning cycles. Consequently, the appropriate approach is to counteract the causes and risks by leveraging materials expertise in combination with intelligent design instead of fighting the effects with ever more aggressive media. Especially in household appliances, a reduced number of components translates into ease of use. The frequent need to partially dismantle the equipment for maintenance and cleaning purposes is facilitated and thus saves time and enhances convenience: an important selling point for the manufacturer of the respective device.

Wear-Resistant, even in Low-Lube and Dry-Run Conditions

Moving machine elements such as seals, wipers or guides typically operate in dry-run conditions under high tribological loads. Therefore, high lifecycle requirements make the utilization of wear-resistant materials indispensable. The excellent wear resistance and creep resistance of nobrox® has been documented by test results.

Figure 2 shows the results of wear tests on food-grade materials from various polymer families. The tests were performed on a wear test bench according to ISO 7148. A rotating ball is pressed against material specimens at a defined force resulting in a ball indentation. The ball indentation volume allows an evaluation to be made of the combined load of wear and creep tendency under defined test conditions. nobrox® W6101 exhibits a similarly positive performance level as PEEK compounds. Compared with PTFE, UHMW-PE and polyamides, nobrox® reveals a clearly lower ball indentation volume, from which good tribological suitability at PEEK level can be derived for applications as a seal, engineered element or guide.

Wide Compatibility with Cleaning Agents

In professional coffee machine applications, nobrox® has already demonstrated its compatibility with foodstuffs. In addition to the polar water content, the filter residues of a coffee beverage contain non-polar fats, proteins and a large number of other ingredients. Various trials with diverse cleaning substances have shown that nobrox® exhibits wide overall media resistance. A chemical attack by cleaning agents commonly used in the food sector can be deemed to be improbable.

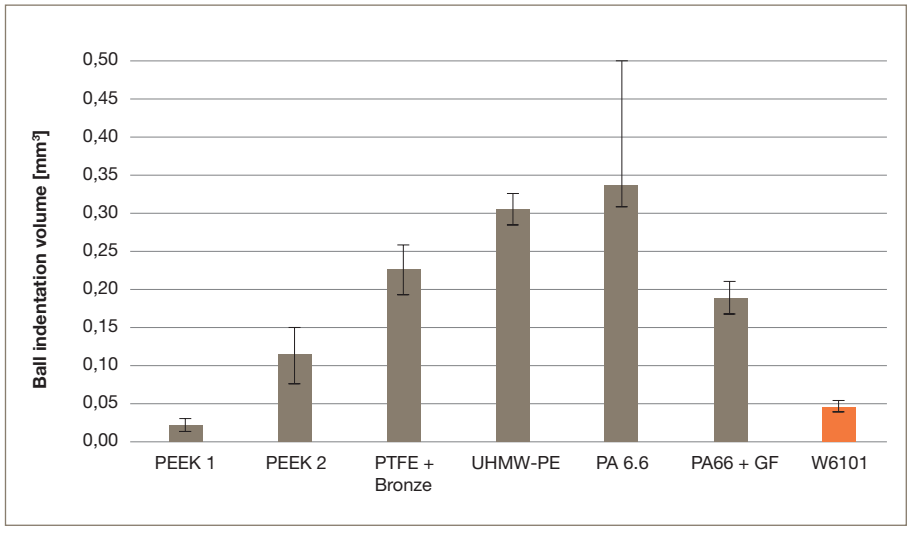


Figure 2: Ball indentation volume [mm³] after testing on a wear test bench acc. to ISO 7148 (ball-prism configuration)

Summary

As a versatile material for engineered components and seals, nobrox®, due to its technical properties and possibilities of component integration and compound variety reduction described above, offers a new approach to solving engineering challenges and reducing costs in the food sector. W6101 extends the nobrox® compound family by another variant that meets all the requirements of the food industry. ■

High Tech in Domestic Kitchens

Pure and Stable Sealing Materials for Use in Modern Kitchen Appliances

Author

Stefan Reichle
Market Unit Manager Industry,
Prädifa Technology Division

Whether they come into direct contact with food or not: most electrical kitchen appliances require seals that prevent ingress of food residues, water or other undesirable foreign matter such as flour or dust and make easy cleaning of the device possible. Parker Prädifa has a long track record of developing innovative materials and sealing solutions for kitchen appliances that meet relevant purity and stability requirements and ensure long life and reliable performance of the equipment.

While only a few decades ago the selection of kitchen aids and appliances was limited to a few simple tools, consumers today find a huge offering of larger and smaller helpers. Electrical appliances in particular have moved into today's domestic kitchens and considerably influence the way we cook. In addition to practically commonplace hand-held blenders, mixers and steamers, "high-tech" devices such as choppers that perform the magic of converting frozen food into delicious, highly aromatic creams or latest-generation fully automatic, app-controlled food processors that via remote control almost independently prepare a finished meal to perfection at the desired time can be found. Irrespective of the type of appliance, they all require seals made of suitable materials.

Rotary Seals – Robust Sealing Solutions for Healthy Smoothies

Handheld blenders and regular blenders easily blitz nuts, vegetables and fruit, and assist us in preparing tasty sauces, smoothies or milkshakes. In addition to seals in the housing, blenders require seals for their blade units. These special rotary seals ensure that the drive shaft is reliably sealed against liquids and solids, and the gearbox and electrical system of the blender are effectively protected.
Parker Prädifa offers a wide range of rotary sealing solutions for these types of applications, starting with simple PTFE washers and rings that are press-fit into the housing, which gives them their final shape required for the respective function, to complex sealing solutions made of PTFE, rubber or other polymers with metal housings and additional energizers such as metallic springs.

In addition to good sealing properties and long life, the cost level is another aspect not to be neglected particularly with kitchen appliances.
Radial shaft seals with an all-rubber body or a metallic back-up element and spring offer the best price-performance ratio for this type of application.

High Demands in Terms of Wear Resistance

These seals have to meet exacting demands, requiring rubber compounds with high wear resistance. This, for one, is due to the high rotational speeds of the blade unit because the blades of handheld blenders rotate at to 10,000 rpm without additional lubrication and, for the other, due to the mechanical influences of the foodstuffs to be blended or blitzed. Particularly hard foodstuffs such as ice cubes and nuts can severely damage a seal. In addition to frictional heat caused by the rotational speed of the blade unit, warm or hot foods such as soup or boiling water result in another thermal load of up to 100 °C.

NBR Compound N9400 – One of the Purest Materials in its Class

For these challenging demands, Parker Prädifa has developed a new NBR material designated as N9400. In addition to the commonly known benefits of NBR compounds such as mechanical strength, wide chemical resistance and good price-performance ratio, the material with its intelligent formulation is one of the purest in its class and meets the requirements for applications in the food or the chemical process industries.
In addition, N9400 is free of polycylic aromatic hydrocarbons (PAH) and nitrosamines as well as FDA-conformant. Aside from the prescribed FDA extraction tests in water and n-hexane, N9400-75 passes other extraction tests in media commonly used in the food and beverage industry. In migration tests according to EU Regulation No. 10/2011 in ethanol, acetic acid and MPPO (modified polyphylene oxide), the material has complied with all limits as well. Furthermore, N9400 is characterized by good aging resistance and compatibility with water. The mechanical properties of the material are summarized in Table 1.

FKM Compound V9196 – the Pure Material for Hot Applications

Modern blenders are not only able to blitz food but as "pots or steamers with a blade unit" can even prepare complete meals program- or app-controlled due to a built-in heating system. These modern kitchen appliances make clearly higher demands on the seal in terms of temperature resistance which can no longer be met by NBR compounds. For these applications, Parker Prädifa has developed the FKM compound V9196.

Benefits of NBR Sealing Compounds

NBR seals are heat-resistant up to 100 °C (short-term up to 120 °C) and exhibit very good general chemical resistance, particularly in mineral oils and greases as well as in animal and vegetable oils and their emulsions with water. Furthermore, NBR seals are characterized by high mechanical abrasion resistance and a good price-performance ratio. In cold conditions, they can be used between -20 °C and -55 °X, depending on the composition of the NBR compound.

Test	Standard	Test specimen	Unit	Required range	Typical value
Hardness	DIN ISO 7619-1	Indenter > 6 mm	Shore A	75 ± 5	76
Density	DIN EN ISO 1183-1 A	Method A	g/cm³	1.94 ± 0.02	1.19
Modulus 100 %	DIN 53 504	S2	MPa	> 5	3.8
Tensile strength	DIN 53 504	S2	MPa	> 15	16.4
Ultimate elongation	DIN 53 504	S2	%	> 300	406
Tear strength	DIN ISO 34-1	Angle test with incision	N/mm	> 8	15.4
Compression set 24h / 100 °C	DIN ISO 815-1	Test spec. B / Method. A / 25 % deformation	%	< 30	22
Glass transition temperature T_g, DSC	DIN EN ISO 11537		°C	< -25	-32
Aging in air, 168 h / 100 °C	DIN 53 508				
Change in hardness			Shore A	< +8	+4
Aging in water, 168 h / 70 °C	DIN ISO 1817				
Change in hardness			Shore A	-10 / +2	+1
Change in volume			%	0 / +10	+5

Table 1: NBR N9400 – physical properties

This material not only meets the high temperature requirements combined with good wear resistance, but exhibits high resistance against caustic cleaning solutions and many acids in the food and chemical industries.

Like N9400, the FKM material V9196 is free of polycyclic aromatic hydrocarbons (PAH-free), nitrosamine-free and FDA-conformant. The compound meets the prescribed FDA extraction test requirements in water and n-hexane and the extraction tests acc. to EU Regulation No. 10/2011 in ethanol, acetic acid and MMPO (modified polyphenylene oxide). In addition, V9196 meets the requirements of other extraction tests in media commonly used in the food and beverage industry. Furthermore V9196 is characterized by good superheated steam resistance and compatibility with water. Due to the material's high purity, applications in baby food production are possible without any concerns as well. The mechanical properties of V9196 are summarized in Table 2.

The Right Material Selection Paired with Appropriate Design

As with all sealing solutions, Parker Prädifa makes the right selection from its extensive material and seal design portfolio together with the customer in the field of modern kitchen appliance technology as well or will develop customer-specific solutions if necessary. his ensures that manufacturers of these high-tech devices offer the reliable performance and long life expected by consumers, plus benefits such as easy cleaning, allowing them to secure a resulting positive image of their products in this fiercely competitive market. ■

Benefits of FKM Sealing Materials

Whenever seals have to deliver both excellent chemical and high temperature resistance, fluorelastomers are the materials of choice. Thanks to their very good chemical and temperature resistance, they are universally usable. Consequently, they rank among the most important sealing materials of all. With FKM elastomers there is normally no shrinkage in the application following exposure to media. Even in the case of heavily swelling mineral oils, volumetric increase will only be moderate. That is why fluoroelastomers are the optimal solution for many applications.

Test	Standard	Test specimen	Unit	Required range	Typical value
Hardness	DIN ISO 7619-1	Indenter > 6 mm	Shore A	80 ± 5	80
Density	DIN EN ISO 1183-1 A	Method A	g/cm³	1.94 ± 0.02	1.94
Modulus 100 %	DIN 53 504	S2	MPa	> 5	9.0
Tensile strength	DIN 53 504	S2	MPa	> 15	24.8
Ultimate elongation	DIN 53 504	S2	%	> 180	268
Tear strength	DIN ISO 34-1 B	Angle test with incision	N/mm	> 10	16.4
Compression set 24h / 200 °C	DIN ISO 815-1	Test spec. B /Method A / 25% deformation	%	< 30	19
Glass transition temperature T_g, DSC	DIN EN ISO 11537		°C	< -15	-17
Aging in acetic acid (pH-Value = 3) 500 h / 100 °C	DIN ISO 1817				
Change in hardness			Shore A	-10 / +2	-8
Change in volume			%	< +10	+5

Table 2: FKM V9196 – physical properties

Author

Dr. Maria Fleischer
Compound and Process Development,
Prädifa Technology Division

PAH-Free Sealing Materials

Polycyclic Aromatic Hydrocarbons
– Environmentally Harmful. Toxic. And Avoidable!

Polycylic aromatic hydrocarbons (PAHs) are a group of chemicals that has increasingly been moving into the rubber industry's focus. While the general public has become aware of these substances primarily due to media reports about toys and flip-flops, the issues they raise affect sealing solutions made of polymeric materials as well. So, what are PAHs, how do they get into elastomer products, why should they be avoided as far as possible, and what efforts is Parker Prädifa making in order to be able to offer PAH-free seals?

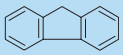
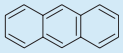
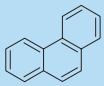
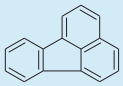
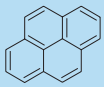
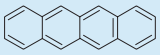
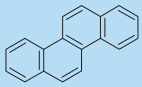
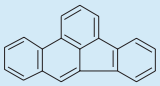
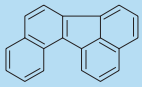
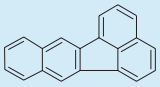
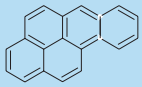
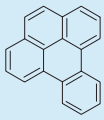
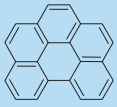
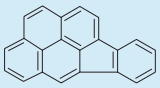
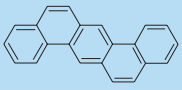
What Are PAHs?

PAH is a collective term that refers to a substance class of organic molecules, all of which are made up of an individual array of condensed benzene rings. The large number and diversity of possible combinations of these rings results in hundreds of chemical substances. The simplest combination is an array of two rings resulting in a compound called naphthalene. Other important PAHs are anthracene or benz[a]pyrene. The creation of an infinite array of condensed benzene rings, which would result in a single layer of graphite, is an intriguing scenario. Common to all of these chemical substances is the arrangement of the electrons which are delocalized across the entire molecular structure, which in chemistry is referred to as "aromatic." The properties of the PAHs depend on the size and structure of the rings. All PAHs are neutral, non-polar solids.

Where Do PAHs Come from?

PAHs are found in nature as components of petroleum and coal with contents possibly ranging between 0.2 and 7.0 %. However, they are also generated in incomplete combustion (pyrolysis) of wood, coal or tobacco. The rule of thumb used here is that the lower the combustion temperature and oxygen concentration, the more PAHs are generated in the combustion process. For instance, PAHs are generated in the combustion of coal to produce electricity, but also in small residential furnaces or fireplaces. PAHs can be released in volcanic eruptions or forest fires as well. However, the PAH source of greatest relevance to the rubber industry is the refining of petroleum to produce basic chemicals. Consequently, important starting products for the chemicals industry may contain PAHs. This may affect plasticizers or industry carbon blacks, both of which are important ingredients for elastomer compound formulations.

PAH-Free Sealing Materials

PAH	Structure	Molecular formula	CAS No.
Naphthalene		$C_{10}H_8$	91-20-3
Acenaphthylene		$C_{12}H_8$	208-96-8
Acenaphthene		$C_{12}H_{10}$	83-32-9
Fluorene		$C_{13}H_{10}$	86-73-7
Anthracene		$C_{14}H_{10}$	120-12-7
Phenanthrene		$C_{14}H_{10}$	85-01-8
Fluoranthene		$C_{16}H_{10}$	206-44-0
Pyrene		$C_{16}H_{10}$	129-00-0
Benz[a]anthracene		$C_{18}H_{12}$	56-55-3
Chrysene		$C_{18}H_{12}$	218-01-9
Benzo[b]fluoranthene Benz[e]acephen-anthrylene		$C_{20}H_{12}$	205-99-2
Benzo[j]fluoranthene		$C_{20}H_{12}$	205-82-3
Benzo[k]fluoranthene		$C_{20}H_{12}$	207-08-2
Benzo[a]pyrene		$C_{20}H_{12}$	50-32-8
Benzo[e]pyrene		$C_{20}H_{12}$	192-20-3
Benzo[g,h,i]perylene		$C_{22}H_{12}$	191-42-2
Indeno[1,2,3-cd] pyrene		$C_{22}H_{12}$	193-39-5
Dibenzo[a,h] anthracene		$C_{22}H_{14}$	53-70-3

Tab. 1: Selected polycyclic aromatic hydrocarbons (PAHs)

Humans and the Environment

PAHs are chemicals that pose risks in several respects. The European Union has rated many PAHs as carcinogenic, mutagenic or toxic for reproduction. A prominent representative in this context is the PAH benz[a]pyrene, a substance that is largely responsible for the carcinogenic effect of cigarette smoke. In addition, PAHs may be toxic for humans or other organisms. PAHs released into the environment will accumulate in plants, soil and air for indefinite periods of time and only degrade slowly. The combination of toxicity and persistence makes PAHs environmentally hazardous substances of concern.
Therefore, limiting PAH emissions and minimizing the use of PAH-containing chemicals is of major importance and the utilization of sealing materials with no or low PAH content, particularly in the food industry, marks a significant step in these efforts.

PAH-Free Seals from Parker Prädifa

The PAH content of seals can be determined by means of analytical chemistry. Due to the large number of different PAHs, the concentrations in a representative selection of 18 chemical substances is determined. The measurement method of choice is GC-MS, using the AfPS GS 2014:01 PAK / QMA 1284 test method.
If the sum of all 18 PAHs is below 0.2 ppm (i.e. lower than 0.2 mg/kg), the seals are PAH-free. Concentrations of less than 10 ppm (10 mg/kg) are deemed to reflect a low PAH content. In addition, a new EU Regulation (REACH VO (EC) 1907 Annex XVII,

VO 1272/2013), setting out a limit of 1 mg/kg for 8 defined PAHs has been in effect since December 2015. To date, the regulation has been restricting its scope to products coming into direct as well as prolonged or short-term repetitive contact with the human skin or the oral cavity under normal and foreseeable conditions of use. In the future, it is to be expected that further laws and regulations controlling the commercialization of PAH-containing products will be enacted at country and EU level. Therefore, Parker Prädifa's aim is to offer PAH-free materials for sealing solutions even before such new laws or regulations come into force. Table 2 provides an overview of selected PAH-free compounds. Their PAH content has been certified by an independent and accredited DEKRA test laboratory.

Parker Prädifa Compound	Polymer base	Brand	Color	Hardness (Shore A)
N9400	NBR		black	75
N9192	HNBR		gray	80
V9169	FKM		black	80
V9196	FKM		black	80
E8924	EPDM		black	70
E8961	EPDM		black	85
V8991	FKM	HiFluor® FB	yellow	75
P5000	TPU	Ultrathan®	green	93
P5029	TPU	Ultrathan®	achromatic	93
P5001	TPU	Ultrathan®	orange	93
P5600	TPU	Ultrathan®	ocher	93

Table 2: Selection of PAH-free sealing materials

Skillful Formulation Leads to PAH-Free Materials

The careful selection of raw materials is of paramount importance in the production of PAH-free sealing materials. An elastomer formulation may consist of 10 to 20 ingredients, depending on the complexity of the sealing application. These ingredients must be carefully coordinated to ensure their production, suitability for processing and subsequent functionality as required by the application. In the production of PAH-free elastomers, time-tested ingredients of the formulation have to be omitted and replaced by low-PAH alternatives without impairing a seal's performance, with a particular focus placed on fillers and plasticizers. Satisfactory processing of elastomers, for instance, requires special additives. The selection of suitable additives depends on the polarity of the rubber, among other things – and a distinction is made between esters of mineral oil and fatty acids, resins and fully synthetic products. Particularly aromatic plasticizers from mineral oil exhibit high PAH concentrations and should be avoided when formulating low-PAH mixtures. Unlike these substances, carbon black as a filler cannot always be avoided for functional reasons but special manufacturing methods are now making it possible to produce low-PAH carbon blacks. Due to extensive screening of raw materials and skillful formulations, Parker Prädifa has succeeded in launching a wide range of low-PAH and PAH-free elastomer compounds on the market. All of these materials exhibit outstanding property profiles for static and dynamic sealing applications.

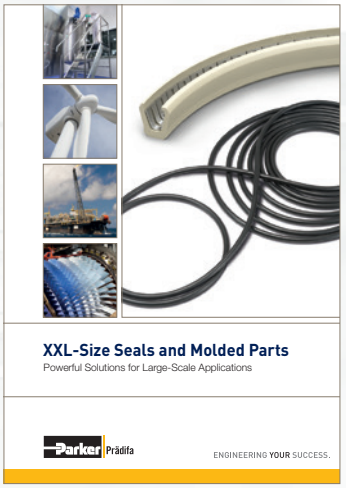
Clean Seals for Sensitive Applications

In addition to complying with legal standards, which goes without saying, Parker Prädifa is highly committed to making an active contribution to environmentally friendly sealing solutions. The development and market launch of PAH-free elastomer materials, which are used particularly in critical food and pharmaceutical applications, marks a milestone in this endeavor. ■

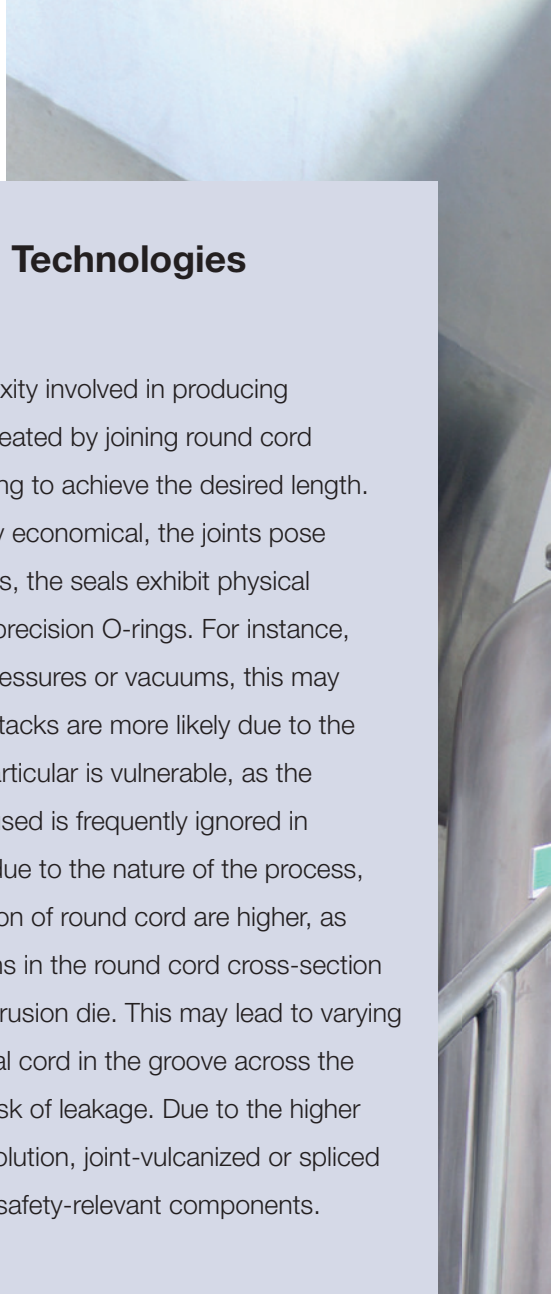
POWERFUL Solutions for LARGE-Scale Applications

XXL-Size Seals and Molded Parts

There is a wide range of industries where, in addition to average-size and miniaturized equipment, large-scale systems are used that require components and sealing systems matching the size of the equipment. While average sealing systems rarely have diameters larger than 100 mm, diameters of several meters are not uncommon in some sectors. Examples include manufacturing plants and equipment, buildings and pipelines, tunnel construction and mining, energy, oil and gas, high-tech medicine, aerospace and many others.
As a specialist in engineered materials, engineering design and process technology Parker Prädifa offers an extensive portfolio of large-size seals and molded parts made of polymers such as NBR, EPDM, FKM, PTFE and PEEK, as well as metal.



New Brochure
Further information on this topic including detailed application examples and specific solutions can be found in a new brochure titled “XXL-Size Seals and Moldings.”



The production of large seals for challenging applications is not simply a matter of scaling up know-how of traditional seal design and machining. The reason is that XXL sizes not only pose particular handling challenges in the manufacturing process, but do so even earlier, in the design and testing stages. Using special compound, engineering design and process technology, Parker Prädifa is able to offer machined seals made of polymer materials such as PTFE or PEEK in diameters of up to 4.5 meters, metallic C-rings in diameters of up to 7.6 meters and precision O-rings made from elastomer materials in practically any desired diameter.

Author

Sabrina Trautmann
Application Engineer,
Prädifa Technology Division

Conventional Production Technologies and their Disadvantages

Due to the high manufacturing complexity involved in producing XXL O-ring seals, these are typically created by joining round cord stock using joint vulcanization or splicing to achieve the desired length. Although both methods are particularly economical, the joints pose a problem. As the joints are weak areas, the seals exhibit physical properties that are inferior to those of precision O-rings. For instance, in applications involving gases, high pressures or vacuums, this may result in leakage. Chemical-physical attacks are more likely due to the joints as well. Spliced round cord in particular is vulnerable, as the chemical resistance of the adhesives used is frequently ignored in subsequent applications. In addition, due to the nature of the process, the tolerances involved in the production of round cord are higher, as irregularities such as diameter variations in the round cord cross-section may occur when the cord exits the extrusion die. This may lead to varying and insufficient compression of the seal cord in the groove across the circumference and a resulting higher risk of leakage. Due to the higher risk of failure of this low-cost sealing solution, joint-vulcanized or spliced round cord seals cannot be utilized in safety-relevant components.

Precision O-Rings in (Nearly) any Desired Diameter

Precision O-rings are manufactured by vulcanization in a closed mold using compression or injection molding. This makes it possible to produce O-rings in small manufacturing tolerances and with good surface quality according to ISO 3601-1 and ISO 3601-3. Due to defined vulcanization parameters, precision O-rings exhibit consistently high mechanical properties across the entire circumference. This high quality level is an indispensable prerequisite for achieving consistently good sealing effects over a long period of time.

The innovative manufacturing technology of continuous vulcanization used by Parker Prädifa, which does not involve failure-prone joints, enables the cost-efficient production of precision-quality O-rings with high mechanical load resistance in nearly any desired diameter, i.e. >200 mm for industrial applications and >380 mm for special applications. The technical properties of continuously vulcanized O-rings are comparable with those of O-rings produced by conventional compression molding. As a result of being molded, these XXL O-rings are quality products for challenging applications.

In addition to precision-quality XXL O-rings, Parker Prädifa offers the development and production of customer-specific geometries in large diameters. A wide range of materials is available according to the application requirements.

Application Example

Pharmaceutical Industry: Sealing Solution for Centrifuge

The challenge >> In the large-scale industrial production of semi-synthetic antibiotics, up to 500,000 liters of antibiotics are produced per batch. For such large-scale production to be economically feasible equipment of corresponding dimensions is required. In addition to large fermenters with diameters of several meters in which the biotech antibiotic is bred, centrifuges of similar dimensions are utilized to separate the antibiotic from process agents. Leakage must be prevented at all cost for safety and economic reasons. A leaking centrifuge might contaminate the antibiotics, resulting in high financial losses or, worse yet, in health and environmental hazards.

The solution >> Parker Prädifa was involved in the project at an early stage to develop a reliable sealing solution. The utilization of continuously vulcanized, i.e. jointless precision O-rings ensures the requisite reliability. Besides the seal design, the compound properties, particularly temperature and media resistance, play a key role. In addition to permanent temperatures of 250 °C, the seal has to withstand the aggressive media used in antibiotics production. The Parofluor® (FFKM) compound V8920 was selected as the suitable material for this application.

Author

Karel Kenis
Business Development and Marketing Manager PTFE, Prädifa Technology Division

XXL Seals Machined from Thermoplastic Materials

Polymer materials like PTFE and PEEK are suitable for machining such as turning or milling. This makes it possible to economically manufacture both larger and smaller volumes because no additional tooling costs for molds are incurred.

Parker Prädifa has been producing complex machined polymer seals with diameters of up to 3 meters for decades. In the light of a growing demand for increasingly large seals Parker Prädifa has continually developed the manufacturing technology of machining further and is now able to offer diameters of up to 4.5 meters at the highest level of quality. The production of even larger diameters is currently in the pipeline.

Application Example

Oil and Gas: Environmental Seals in FPSO Swivel Stacks

The challenge >> Swivel stacks are the centerpieces of Floating Production Storage and Offloading (FPSO) units. They form the flexible connection between the subsea riser and the storage and distribution systems on the vessel. Swivel stacks require complex sealing systems, both for interior and environmental sealing.

The solution >> Parker Prädifa offers large seal solutions for these applications in both areas, some of which are combined with back-up ring combinations. Manufacturing examples include environmental seals with complex geometries in diverse materials such as UHMW PE and PTFE in diameters of up to 4.5 meters.

Author

Thorsten Kleinert
Business Unit Manager
Composite Sealing Systems,
Prädifa Technology Division

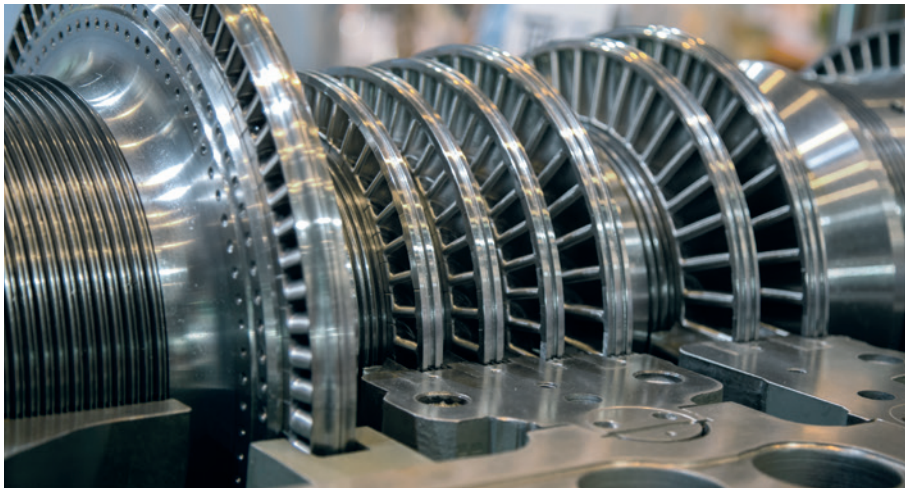
Metal Seals for Harsh Application Conditions

The most important manufacturing technologies used to produce metal seals from stainless steel or nickel alloys are rolling, forming, CNC machining, welding, heat treatment and coating/plating. In its more than 60-year history of producing metal seals, Parker has continually tackled the challenge of manufacturing increasingly large metal seals. Currently, spring-energized C-rings with a diameter of up to 7.6 m can be produced for which special forming machines and patented welding techniques were developed. They are supported by optimized special heat treatment and electroplating processes that make it possible to manufacture high-quality products even in such large dimensions. Additionally, Parker offers non-rotationally symmetric metal seals. These E-, O- and C-seals can be produced in lengths of up to 2.3 m on machines specifically developed for this purpose.

Application Example

Energy Production: Gas Turbines with up to 800 MW Capacity

The challenge >> Temperatures inside the turbine rise to 650 °C under high pressure. This pressure and the thermal expansion lead to the formation of gaps at the housing joints through which the hot medium can escape to the outside, resulting in a potential hazard to life and limb. Additionally, this considerably reduced the effectiveness of the turbine.



The solution >> Gas turbines are optimized by using metal seals featuring an advanced segmented design. Either metal E-seals or spring-energized metal C-seals are utilized depending on the expected size of the sealing gap. Metal E-seals are characterized by low compression force and high resilience, whereas C-seals have less resilience and better sealing performance.
Both reliably seal the gap between the housing segments.
Linear metal seals are inserted between the upper and the lower part of the housing in the turbine, which prevents leakage at these critical joints.

To facilitate assembly of the housing halves weighing several tons, Parker has developed a special technology that causes the seal to completely rest inside the groove during installation and to contact the opposite flange area only after the turbine's initial run. Application-critical transitions between seals and surrounding components are effectively closed using special end pieces, designed accordingly in the customer's hardware. ■

New Brochure
Additional information on this topic can be found in a new Parker Prädifa brochure titled “Single-Use Consumables”.

Author

Berthold Röhrich
Market Unit Manager
Life Sciences,
Prädifa Technology Division

Single-Use Consumables for Biotechnical Processes

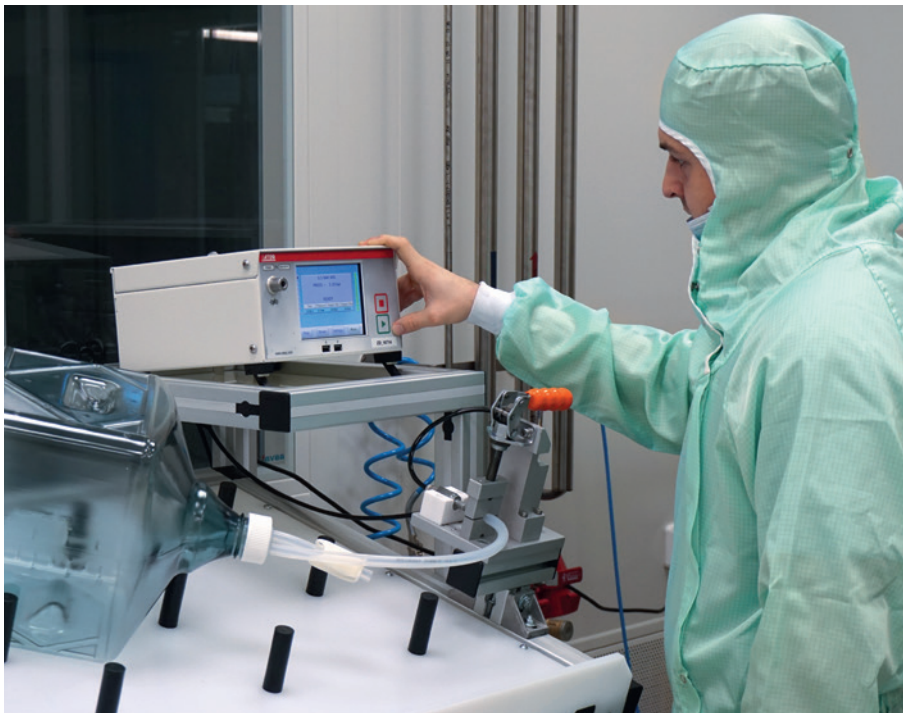
Overmolding Technology and Customer-Specific Validation Ensure Safe Consumables

Polymer-based single-use systems reduce risks and enhance efficiency in biotechnical processes compared with multi-use alternatives based on steel and glass. Not least due to these advantages, market demand for and acceptance of these devices intended for one-time use has clearly increased in recent years. Using modern overmolding technology combined with biopharmaceutical process know-how and respective validation procedures, Parker Prädifa offers customized solutions and corresponding validation packages.

The utilization of single-use systems (SUS) for upstream and downstream processing in the biotechnical and pharmaceutical industries has become established practice in many areas such as vaccine production thanks to the advantages these devices offer. In addition to platform technologies such as bioreactors, mixing systems or chromatography columns, consumables are of major importance as well. They include all the systems that transport and/or store fluids – such as sampling systems, transfer systems and filling systems. They typically consist of tubes, plastic containers or bags, filters, aseptic connections and filling components like droppers and manifolds.

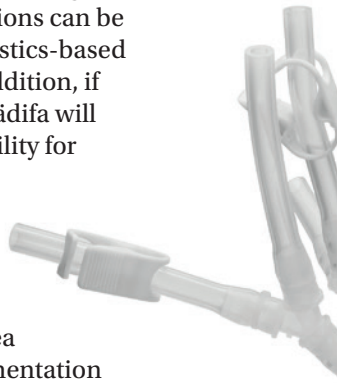
Sterile and Immediately Ready for Use in Production

Parker Prädifa's approach is centered on delivering sterile and ready-to-use systems based on plastic components to the production environments of users in biotechnology and the pharmaceutical industry. Subsequently, the systems merely have to be connected according to their intended purpose and disposed of after use. This eliminates complex logistics and assembly requirements of the single components as well as post-use sterilization in the users' operations. In addition, flexibility in the customer's production workflow is clearly enhanced in spite of low capital expenditures.



Solutions Perfectly Tailored to the Production Environment

Solutions tailored to the customer's production environment are necessary to ensure optimum use of the aforementioned benefits of SUS systems. As an independent supplier and system integrator, Parker Prädifa develops these tailored systems, drawing on longstanding experience in polymer materials engineering, in-house clean-room production in Central Europe and extensive process engineering know-how, while offering maximum flexibility in terms of using standard components from established manufacturers. For instance, even stainless steel or glass solutions existing in the customer's operations can be converted into plastics-based SUS systems. In addition, if desired, Parker Prädifa will assume responsibility for coordination and complete project management, from the initial idea through to implementation in volume production.



Customer-Specific Validation Packages

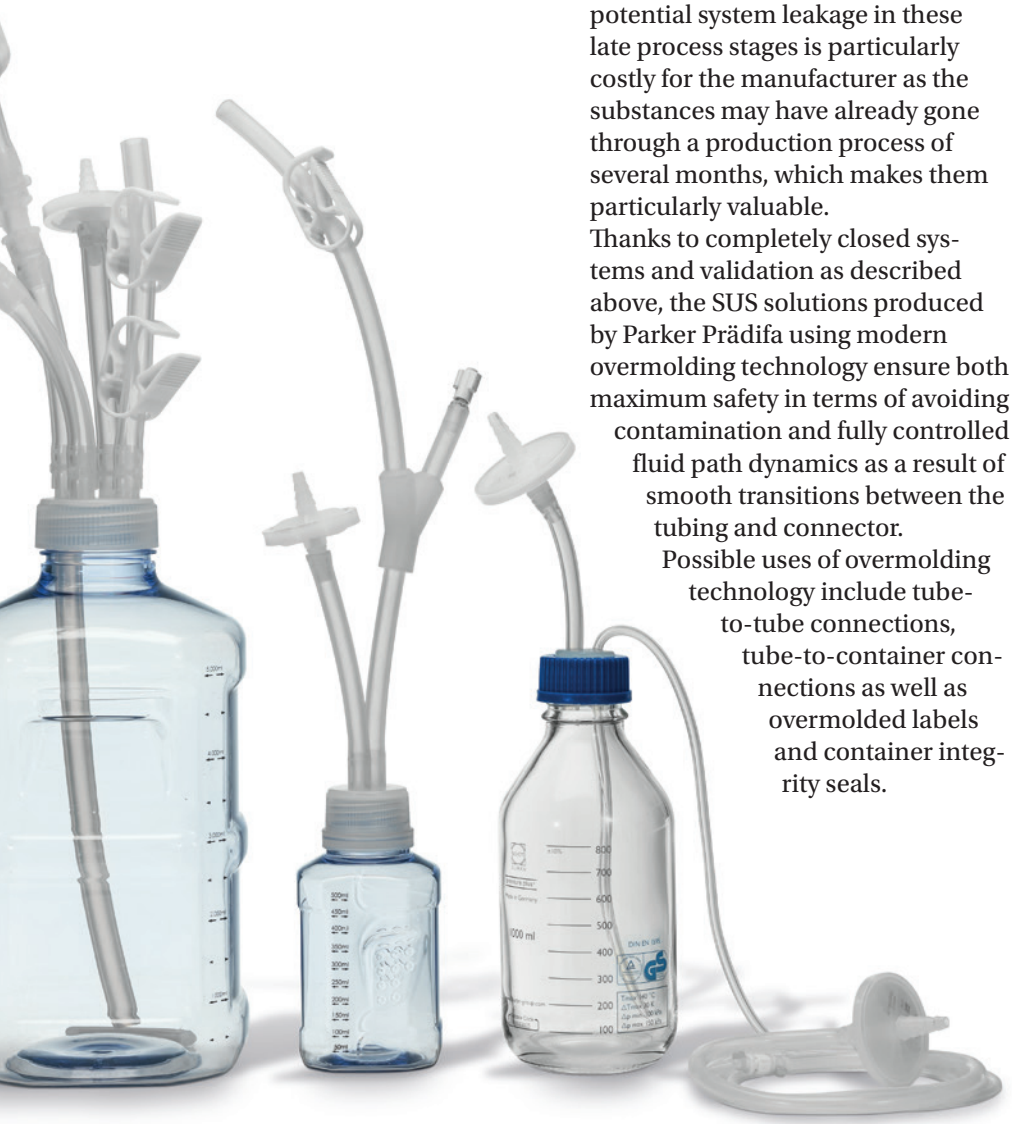
The SUS performance portfolio is complemented by the exceedingly important aspect of system validation. As nearly every SUS consumables system is unique, there are no catalog solutions or finished validation packages available. Instead, the respective validation package is defined in close coordination with the user, combining validation guidelines for the

single components with the manufacturing process of the system and the customer's system requirements – e.g. Particle Monitoring USP 788 / EP 2.9.19, Bioburden ISO 11737, USP Class 6 / ISO 10993, USP 661, Endotoxines and Shelf-Life.

Parker Prädifa validates the integrity of the systems strictly at system level to ensure that there is no leakage. For this purpose, the systems are connected to a calibrated test set-up in the GMP-conformant clean room where leakage rates can be measured and documented using compressed air. Following the tests, the systems are not necessarily unfit for use but may continue to be utilized as reference or retention samples to save costs.

Maximum Safety Thanks to Modern Overmolding Technology

Compared with components and systems used in upstream processes, SUS solutions for sampling systems or in final filling applications have to meet special requirements. The reason is that sampling and final filling are the final process steps on the way to the finished product and therefore require maximum levels of integrity and excellent accuracy to guarantee a contamination-free and precisely dosed final product.
In addition, any damage caused by potential system leakage in these late process stages is particularly costly for the manufacturer as the substances may have already gone through a production process of several months, which makes them particularly valuable.
Thanks to completely closed systems and validation as described above, the SUS solutions produced by Parker Prädifa using modern overmolding technology ensure both maximum safety in terms of avoiding contamination and fully controlled fluid path dynamics as a result of smooth transitions between the tubing and connector.
Possible uses of overmolding technology include tube-to-tube connections, tube-to-container connections as well as overmolded labels and container integrity seals.



Extensive Product Portfolio and Pharma-Grade Materials

Commensurate with the various applications for SUS systems, Parker Prädifa's product portfolio ranges from final-fill systems, sampling systems, waste containers and bubble traps, solutions for cold-chain transportation through to media preparation and buffering. Parker Prädifa offers the entire portfolio of overmolding solutions based on pharma-grade silicone and TPE materials. Naturally, novel SUS components can be developed in cooperation with the customer as well. ■

New S
Joints

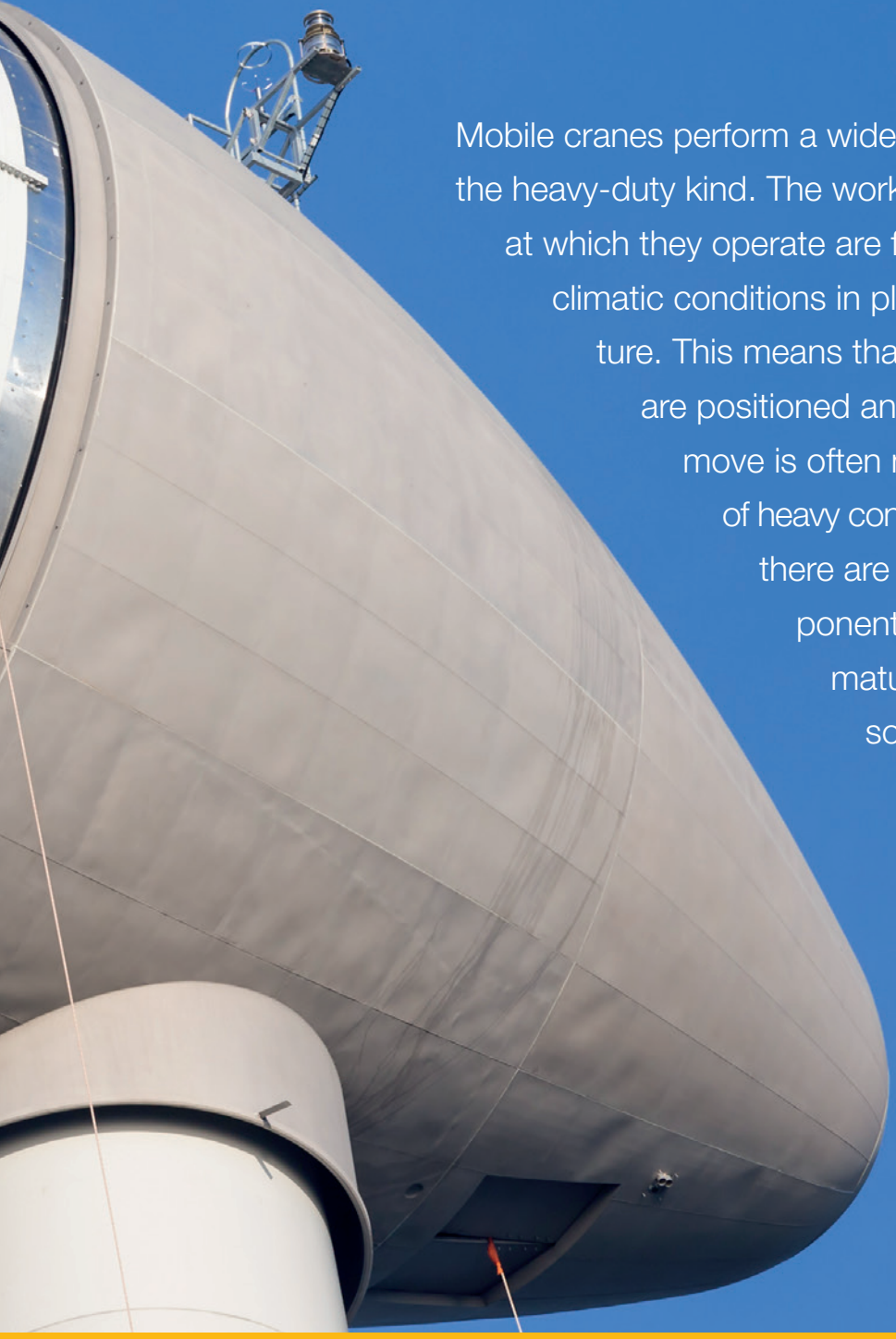
Authors

Michael Dillmann
Account Manager,
Engineered Materials Group
Europe

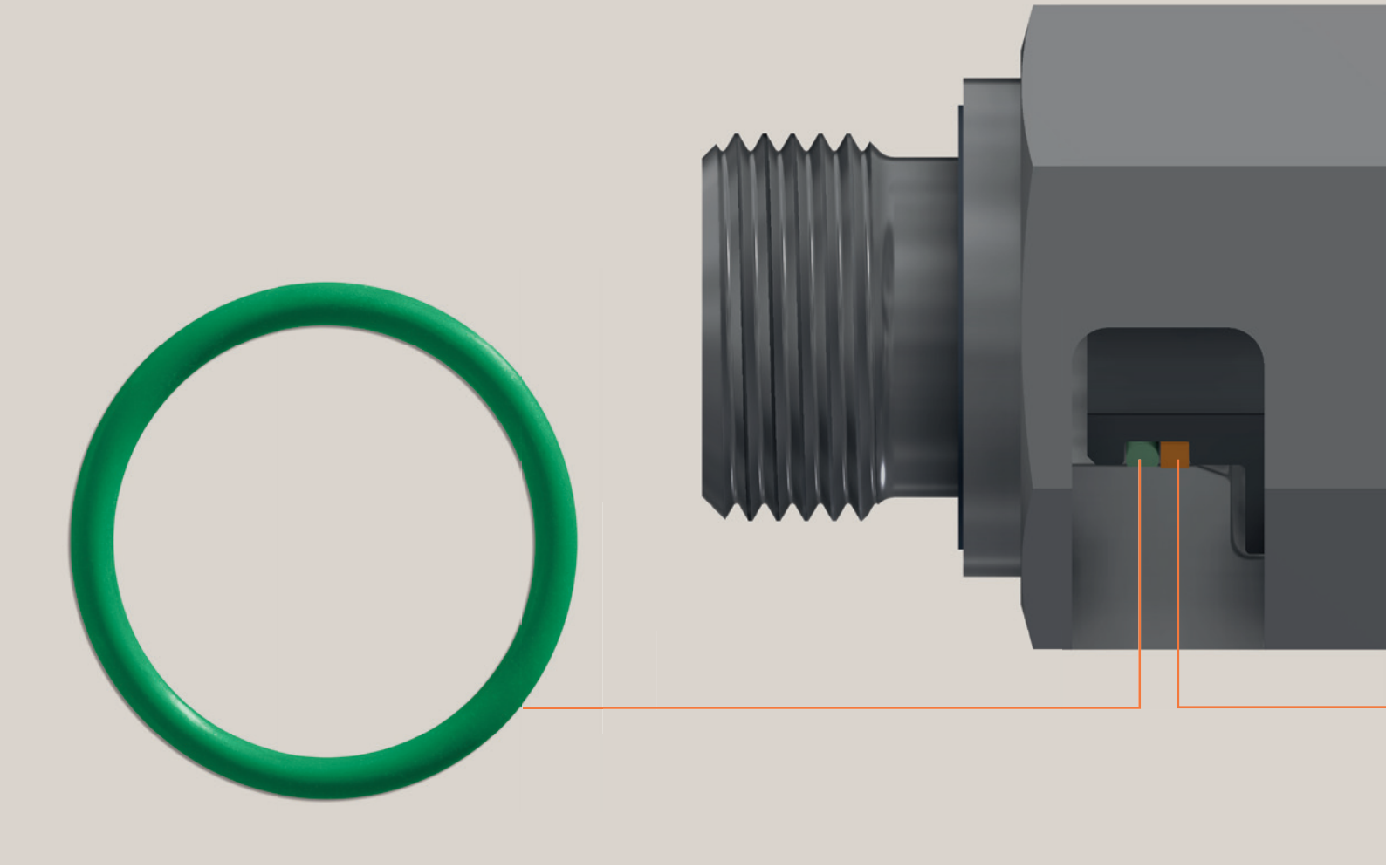
Carsten Schippers
Research & Development,
Fluid Connectors Group,
Tube Fittings Division Europe

ealing Solution for Hydraulic Swivel in Mobile Cranes

Ultrathan® and nobrox® Material Combination Prevents Premature Wear



Mobile cranes perform a wide variety of tasks, typically of the heavy-duty kind. The work they do and the locations at which they operate are frequently exposed to harsh climatic conditions in places with insufficient infrastructure. This means that the sites at which the cranes are positioned and the environment in which they move is often not entirely suitable for this kind of heavy construction equipment. Accordingly, there are high loads acting on the components, which often wear out prematurely as a result. A new sealing solution for swivel joints in cranes subjected to high loads, which combines a polyurethane O-ring with a nobrox® back-up ring, has effectively remedied this issue.

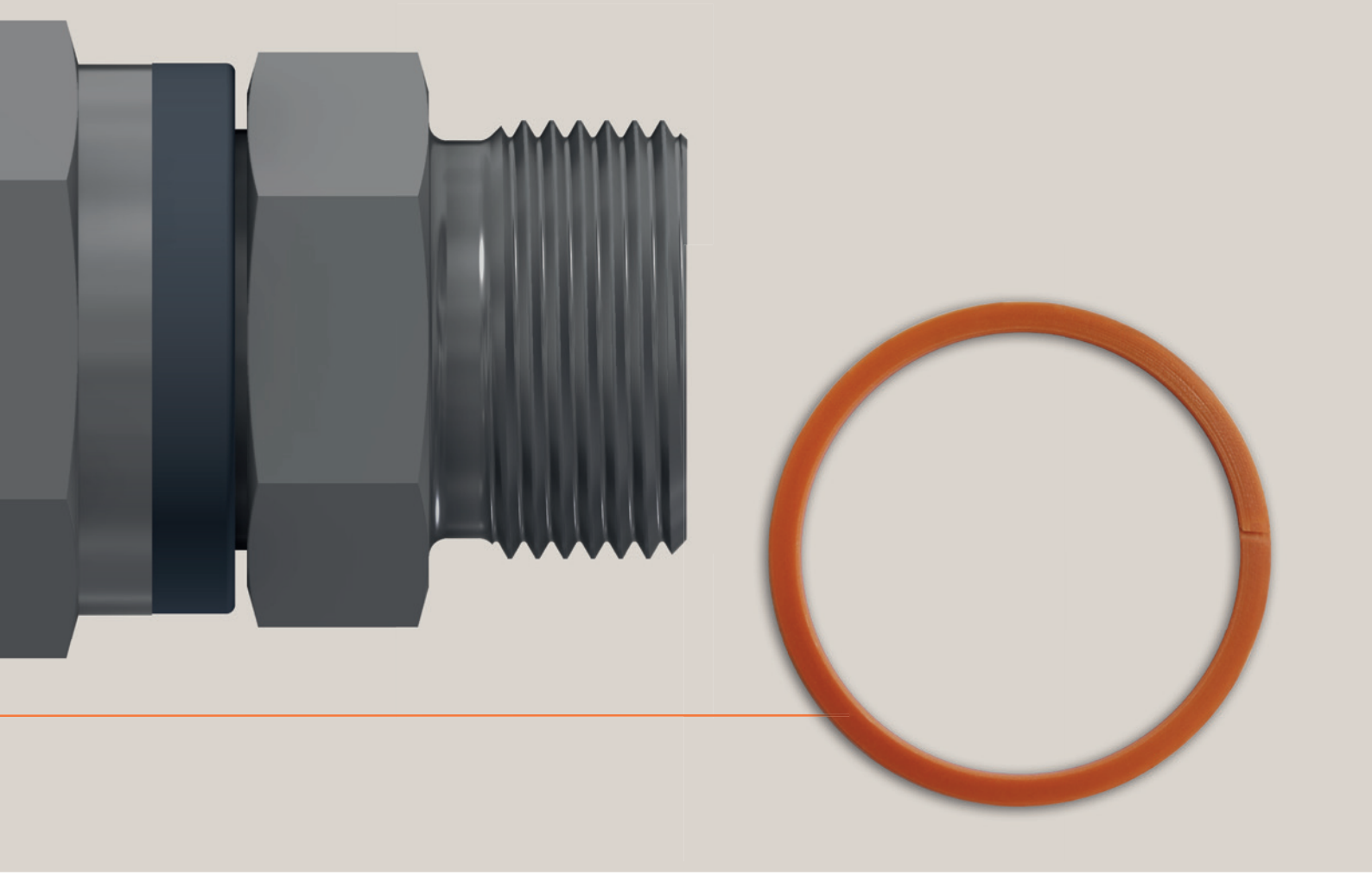


Swivel joints are generally used for swiveling and/or rotating hydraulic connectors. The type of ball bearing mounted swivel joint from Parker Ermeto, which specializes in a wide range of industrial components, is unique in this form and features a particularly robust design. In addition to applications in booms or cranes, these swivel joints can essentially be installed in excavators, drill units or diverse stationary applications as well.

Aside from a ball bearing mounted race made of bearing steel, which transmits rotary movements even under extremely high interior pressure loads of up to 420 bar with nearly no losses, such high-performance swivel joints require a seal that encloses the hydraulic fluid while permitting relative rotary movements in its seat under maximum contact pressure without abrasion or extrusion. Drag-in of the hydraulic fluid into the ball guide must be prevented – even after an extremely cold night when the mobile crane after an eight-hour period of rest with unheated units is set up, i.e. started up again. Furthermore, a sealing ring as atmospheric protection is provided against external dirt and drag-in of dust or condensate.

High Contact Pressures and Slowly Rotating Movements as Causes of Seal Wear

The ball bearing mounted swivel joints utilized in mobile cranes posed the problem that the NBR O-rings and back-up rings used for sealing could extrude into the gap between the ball bearing mounted pivot and the surrounding housing after a relatively short period of time. Consequently, the back-up ring was practically pulverized, resulting in wear of the O-ring. The extremely high contact pressures and the simultaneous slow rotating movement were identified as the causes. As a result, the sealing elements were pushed into the gaps induced by the manufacturing process, which ultimately led to seal wear. This effect can be observed during the controlled lowering of the jib under high operating pressures and simultaneous occurrence of extreme



flow velocities, i.e. above those established by the engineering design criteria.

New Ultrathan® and nobrox® Sealing Solution Remedies the Issue

Thanks to its excellent wear resistance and good anti-frictional properties, Parker Prädifa's new thermoplastic sealing material nobrox® (PK) was taken into consideration as a material for the back-up ring at an early stage. Another objective was to enhance the robustness of the O-ring as well by utilizing a material with higher wear resistance. Therefore, instead of the previously used NBR material, an Ultrathan® (TPU) compound from Parker Prädifa's portfolio was selected.

Service Life of Sealing System Decisively Extended

In the physical laboratory, the swivel joint with the new sealing set was tested in a wide range of extreme operating conditions exceeding those of the application and simulating the operating parameters actually prevailing on the vehicle with maximum realism. These tests run over 10,000 cycles were successfully passed, revealing that the maintenance-free operating period of the swivel joint far exceeds the typical frequency and operation sequences of a jib. In the subsequent evaluation of the parts no visible wear was discernible.

Utilizing the new sealing solution jointly developed by Parker Ermeto and Parker Prädifa, the customer can now be sure that in the future there will be no more swivel joint failures in its cranes due to seal wear. ■

Innovative Multi-Component Technology for Sealing Elements and Engineered Components

Multi-Component Solutions Feature Extensive Material Combinations, Offer Great Freedom of Design and Savings Potential

Author

Thomas Braun
Marketing Manager,
Prädifa Technology Division

Parker Prädifa offers an extensive selection of material combinations for multi-component designs such as rubber/plastic, rubber/metal and plastic/plastic. The product portfolio ranges from multi-component sealing elements through to complex designs consisting of two or more components. The utilization of multi-component technology based on specific engineering and manufacturing know-how enables the integration of several components and/or functions in a single component design. As a result, the process chain can be shortened and logistics and assembly requirements reduced.

Extensive Selection of Material Combinations

Carrier	**Elastomer**							
	AEM	EPDM	FKM	HNBR	NBR	NR/SBR	SBR	VMQ
Steel	✓	✓	✓	✓	✓	✓	✓	✓
Aluminum	✓	✓	✓	✓	✓	✓	✓	✓
Brass	✓	✓	✓	✓	✓	✓	✓	✓
ABS								
PA	✓	✓	✓	✓	✓			✓
PBT		✓			✓			
PC								
PEEK								
PP								
PPE		✓				✓	✓	
Rubber/Fabric			✓		✓			

Multi-component technology combines components made of different materials in an integrated molded part. These composites are not limited to elastomer compounds featuring diverse properties but, due to the use of multi-component injection molding technology, include a wide range of so-called hard/soft composites where a thermoplastic material or metal forms the hard component (carrier) while the soft component consists of an elastomeric material. There is a chemical bond between the carrier component and the elastomer which can be created either with or without the use of a primer.

New Development Potential due to Extensive Freedom of Design

Due to the combination of the specific advantages of various materials in a single component, completely new development potential can be realized. Extensive freedom of design enables the creation of complex yet compact and weight-saving geometries and extended component functionalities. As a result, products which, in terms of economic feasibility, would hardly be achievable or only with great difficulty using conventional methods are possible this way.

Savings Potential due to Reduced Requirements

In addition, the integration of several components or functions in a single component offers the user further benefits and savings potential, for instance in the form of a shorter process chain, simplified assembly and reduced requirements in logistics and quality assurance.

Diverse Applications in Various Industries

Thanks to the large compound selection and combination options, Parker Prädifa is able to produce multi-component products for a wide range of automotive and industrial applications. Examples include housing components with a static sealing function (also in relevant IP protection classes), housing components with rotating shafts, electric motors, drive system seals or seals with positive/-non-positive locking retention. Quality assurance options for these products include dimen-sional inspection using AOI (automatic optical inspection) and others. ■

TPU	TPE-E	TPE-S	TPE-O
✓	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
✓			
✓		✓	✓
✓	✓	✓	
✓		✓	
		✓	✓

Instead of Fans and Heat Sinks

Techniques for Thermal Management of Electronics

The trend towards more compact, portable devices in industrial as well as consumer applications has led to new challenges for designers in the area of thermal management. Increased power densities and smaller enclosures that are often sealed mean that traditional approaches such as fans and heat sinks are not appropriate. Parker Chomerics offers alternative solutions to tackle these challenges.

Author

Stephen Shakespeare
Thermal Product Manager,
Chomerics Division Europe

Pre-Cured Dispensable Gels

Highly conformable, one-component pre-cured silicones, such as the THERM-A-GAP® range from Chomerics, that can be dispensed are ideal for filling large and uneven gaps in electronics assemblies. The viscoelastic paste is a form-stable, cured silicone material that takes considerably less force to deform during assembly than traditional form-stable gap fillers. This characteristic helps avoid placing excessive stress on component solder joints and leads that can result in either premature failure of the device or damage to the circuit board on which it is placed.

Some applications require that the thermally managed device be electrically isolated from the chassis or heatsink to which it is coupled with the thermal gel. In this case, the inclusion of small glass beads in the gel can provide an effective compression stop, or spacer, which ensures the two surfaces do not come into direct physical contact.

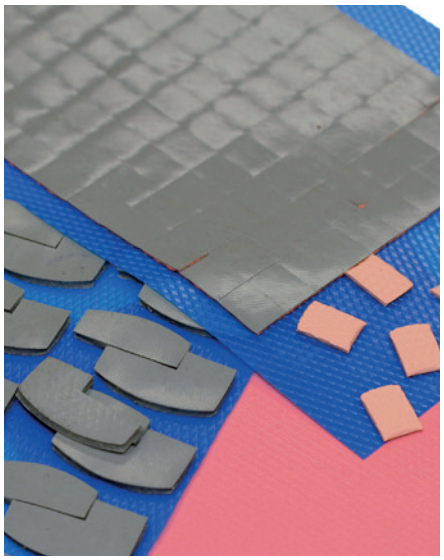
Insulator Pads

These are generally very thin materials (around 0.25 mm) that comprise a silicone elastomer blended with a thermally conductive filler. Fiberglass cloth is commonly used to reinforce the material and provide some resistance to cut-through that would reduce the electrical isolating properties of the material. More resilient carrier materials are available for applications with higher assembly pressures or where the risk of cut-through is greater. For example, Cho-

Therm T441 comes in three thicknesses (0.2 mm, 0.33 mm and 0.46 mm) and is formulated for improved electrical isolation and cut-through resistance. Parker Chomerics offers a wide choice of insulator pad materials. These use a variety of fillers that provide a wide range of thermal and electrical performance levels. Options such as low-tack adhesive coatings, pressure sensitive adhesives and tabbed release liners, which aid assembly, may also be specified.

Adhesive Tapes

Thermally conductive tapes, such as the Parker Chomerics THERMATTACH® range, provide effective alternatives to mechanical fasteners such as screws, clips and rivets for bonding heatsinks to either ceramic or metal device packages. They have the following benefits: lower assembly times, smaller footprints and reduced material costs.



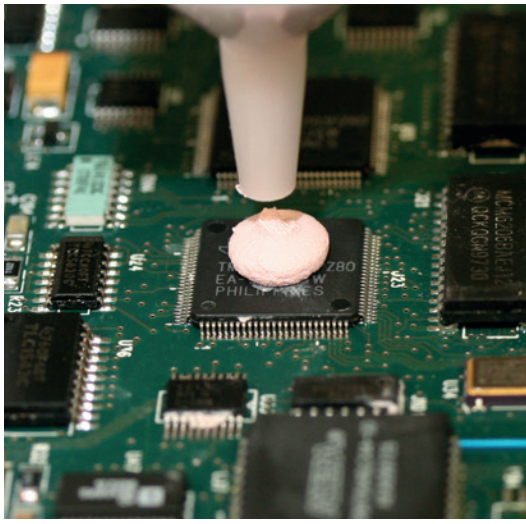
Gap Filling Pads

Perhaps the most successful of the "new generation" of thermal interface materials has been silicon-based gap filler pads. These have supported the utilization of equipment enclosures or chassis as heat dissipaters in place of costly and heavy dedicated heatsinks. By fitting a piece of soft gap filling material between a device requiring thermal management and an enclosure, heat can be channeled away effectively. Because of the typically large surface area of the equipment enclosure coupled with the fact that it provides a direct thermal path to the lower temperature of the "outside world," adopting this approach can also negate the need for fans where they were previously required for a specific design. In some applications, gap fillers can also allow the design to be completely sealed and therefore suitable for use in harsh environments where moisture may be present.

Gap filling pad materials are available in a wide range of thicknesses that now extends beyond 5 mm, allowing even very large gaps to be bridged. Their extremely soft nature (as low as 4 Shore 00) means that large mechanical tolerances can be taken up with relatively low assembly forces being used. Accurate blending of silicone-based gap fillers, using a range of materials with different thermal conductivities, results in a choice that allows designers to select a material that accurately meets the thermal requirements of their specific design.

Thermal Conductivity and Thermal Impedance as Key Values

Maximum values of thermal characteristics are around 6.0 W/m-k and increasing. However, published thermal conductivity values should always be questioned. This is because, depending on the test method used, they can give misleading indications of performance if not cross-referenced with published values



of thermal impedance. Chomerics' thermal impedance values and thermal conductivity values are measured using the ASTM D5470 method and, in the case of THERM-A-GAP® pads, this defines the thickness and pressure at which the measurements were taken. These higher-performing gap fillers typically use more expensive ingredients or have more stringent requirements in terms of blending.

Continuous Evolution

The world of thermal gap fillers and interface materials continues to evolve as the cooling requirements for applications in the automotive, aerospace, consumer and medical markets continue to demand lower prices and higher performance. The criteria which engineers use to select these interface materials will by necessity include thermal conductivity. However, other properties of the material such as its hardness, dielectric strength, dielectric constant, compression set, cut-through resistance, toughness, tensile strength and resistance to chemical and environmental attack can be equally important, as well as its suitability for rework or repair. ■

Parker Hannifin GmbH
Engineered Materials Group Europe
Arnold-Jäger-Str. 1
74321 Bietigheim-Bissingen · Germany
Tel. +49 7142 351-0
Fax +49 7142 351-432
E-mail praedifa@parker.com