



ESSENTIAL

FREUDENBERG SEALING TECHNOLOGIES
THE MAGAZINE – ISSUE #1 – 2013

INNOVATIVE SOLUTIONS

New sealing products unleash new potential
in a host of industry sectors

THE UNCONVENTIONAL THINKER

A portrait of innovation seeker Dr. Peter Kritzer

TROUBLESHOOTING AROUND THE GLOBE

A visit with the sealing fire fighters

RICH SPOILS WITH LEAN METHODS

Robots heat valve-stem seals



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LESS is the technology package that is increasing the efficiency of modern internal combustion engines and putting alternative drive technologies on the fast lane.



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FEEDBACK, CONTACT AND IMPRINT

#1

CLIMATE CHANGE AND THE FINITENESS
OF NATURAL ENERGY SOURCES

are among the greatest challenges of the 21st Century. Sustainability has become an indispensable concept for community, politics and the economy worldwide. Today a basic principle for corporate action is:

**IF YOU DO BUSINESS SUSTAINABLY, YOU WILL
ENJOY SUSTAINED SUCCESS.**

GLOBAL CHALLENGES THAT MOVE US

#2

AS A RESULT, SUSTAINABILITY IS A KEY
DRIVER FOR THE INNOVATIONS

that reduce the emission of climate-warm-
ing greenhouse gases, that consume
natural resources as sparingly as possible
and that use renewable energy. One
example is the technological transition in
the automotive and energy industries.

#3

IN VIEW OF THE GROWING WORLD POPULATION

and the associated need for consumer goods, energy and mobility, new resources and energy-saving technologies are in demand more urgently than ever. Five people are born every two seconds. By 2050, the world's population will have grown from around 7.1 billion to 9.3 billion people. In addition, there is rapid economic growth in many regions of the world, especially the up-and-coming BRIC nations.

#4

THE GLOBAL DEMAND FOR FOOD WILL CLIMB BY ABOUT 70 PERCENT.

In the last 10 years, the global inventory of cars has already grown by 250 million units and is now at more than 1 billion units. The OECD expects that the number of cars will triple in India and increase tenfold in China by 2030. The International Energy Agency (IEA) expects an increase in global energy use of 50 to 70 percent by 2030. This suggests that further growth in the consumption of resources and CO₂ emissions is unavoidable, since fossil fuels such as oil, natural gas and coal currently cover more than 80 percent of the world's primary energy demand.



VISIONARY AND TREND CONSCIOUS

FREUDENBERG SEALING TECHNOLOGIES CONSIDERS SUSTAINABILITY TO BE PART OF CUSTOMER SERVICE.

With forward-looking research and innovative products, the global market and technology leader in sealing technology is gearing up for key megatrends – and is developing new potential for sustainable technologies in numerous industrial sectors.





4
QUESTIONS
to

CLAUS MÖHLENKAMP
Speaker of the Board of Management of
Freudenberg Sealing Technologies.
A conversation on sustainability,
innovation and growth.

OUR MATERIALS
EXPERTISE IS THE

“BREEDING GROUND FOR INNOVATION”

FREUDENBERG SEALING TECHNOLOGIES has decades of experience in materials development. It is our inestimable know-how for the development of novel solutions that successfully combine ecology and business. A conversation with Claus Möhlenkamp, Speaker of the Management Board, on sustainability, innovative power and growth.

1 MR. MÖHLENKAMP, HOW SUSTAINABLE IS FREUDENBERG SEALING TECHNOLOGIES? For decades, sustainability has been a key component of our company values and strategy. In our principles, we talk about a long-term orientation. Our balance sheet shows a high capital ratio, a foundation for sustainable actions. It allows us to act proactively beyond the ups and downs of the financial markets. Our own research into trends and the future, along with exchanges of information with our customers, sets our direction. In our role as a supplier, we always understand that our task is to help our customers bring sustainable products to the market.

2 CAN YOU CITE AN EXAMPLE FOR US? There is substantial potential slumbering in our sealing technology. It could make valuable contributions to sustainable mobility, for example. We have consolidated this potential under the phrase “Low Emission Sealing Solutions,” or LESS for short. In conventional powertrain technology, LESS includes product innovations that reduce frictional

3 SO FREUDENBERG SEALING TECHNOLOGIES’ CAPACITY TO IDENTIFY TRENDS AND IMPLEMENT THEM IN TECHNICAL INNOVATIONS IS A COMPANY TRADITION? Clearly yes. Our materials expertise, developed over decades, has formed a breeding ground for innovation. The advantage of being a family-owned company is stamina. Our research and development work is long-term oriented. We consistently rely on breakthrough innovations, as well as continual improvement. Year in and year out, we dedicate substantial resources to them. In the process, we not only focus on innovative materials and products, we concentrate on resource-conserving and energy-efficient production processes as well. For example, our especially material-conserving SUL production technology has already been awarded three prestigious environmental and innovation prizes. A sustainable approach to working with an inventive spirit as a resource is one of our fundamental principles. Or, to put it another way: Innovative power is the DNA of the Freudenberg Sealing Technologies brand.

4 WHAT GROWTH STRATEGY ARE YOU PURSUING? As the global market and technology leader in the sealing business, we have a good starting position for further growth. Freudenberg Sealing Technologies is active in all key industries. Based on megatrends, we have defined markets and market segments where we want to grow: The automotive business remains important to us;

losses, optimize the combustion process, support advanced downsizing concepts and start-stop systems, and facilitate weight reductions. Even today, we are also offering tried-and-tested materials and sealing solutions for alternative fuels and powertrain concepts. Freudenberg founded its own company for fuel-cell technology years ago.

other market segments such as chemicals, pharmaceuticals and energy will increasingly join it. In parallel, we are pursuing a regional growth strategy centering on the BRIC nations. Thirdly, we want to expand our technology portfolio – organically as well as through acquisitions. In the past year, we entered into a joint venture with the Schneegans Group. We are thus investing in multicomponent injection molding production and in forward-looking plastic products, especially for the auto industry.



INNOVATIVE

SOLUTIONS

Freudenberg Sealing Technologies has decades of experience in materials development, representing invaluable expertise in the development of innovative solutions that combine economy and ecology.

NUTRITION AND HEALTH – THE SURE WAY TO FULL FLAVOR

Food production will have to be nearly doubled by 2050 to feed a growing global population, according to the Food and Agriculture Organization of the United Nations. As a result, long-term trends include increasing automation with long machine operating times and high capacities, along with greater flexibility for rapid product changes. Special sealing solutions help to increase operating life, as well as process and food safety, while minimizing service and maintenance.



NO OPPORTUNITIES FOR GERMS

Germ formation is a continual threat in equipment and devices that come into direct contact with foods or beverages. At the same time, bacteria tend to thrive in hidden locations. An ideal breeding ground for them can form under nuts and inside hexagonal screw threads. For the first time, complete screw connections based on hygienic design are now an effective remedy. They consist of the Freudenberg external-sealing **Hygienic Usit**[®] washers and the NovoNox specially rounded, high-gloss polished screws

and cap nuts specifically tailored to them.

The combination of the Hygienic Usit, an even flange seat and polished, rounded screw and nut corners does not allow impurities either to pene-



trate or adhere – an extremely high degree of hygiene for the entire screw connection.



ALL-PURPOSE WEAPON AGAINST THE TRANSFER OF FLAVORS

But it is not only germs that are causing headaches in the food and pharmaceutical industries. One phenomenon typical of the industry is the transfer of flavors during product changeovers. You know the problem if you have ever drunk a fruit tea from a pot that previously held coffee. Freudenberg has brought out an all-purpose weapon against this adulteration of taste – the sealing material **Fluoroprene[®] XP**.

About 3,000 approved flavoring agents and their interactions also eat away at the durability of sealing materials just as greasy or oily media and abrasive cleaning agents do. FKM¹ and NBR² often fall victim to these exposures, swelling up as a consequence. EPDM³ and silicone cannot always be used since they, in particular, increase the risk of flavor migration into the material and thus cross-contamination after a product change.

Fluoroprene XP was especially tailored to these requirements. Whether it is acid, base, moisture, grease or most flavorings – nothing can

compromise it. The all-around problem-solver is even resistant to lime flavors and other terpenes. A universal solution, the material has another crucial advantage: The cost of procuring, certifying and stocking seals of different material types declines.



FLEXIBLE FOLDS COMBAT INCREASED SHAFT RUN-OUT

When flavorings, raw materials and other ingredients are processed into dough or raw mixtures in huge mixing plants, major forces act on the stirrer. They promote considerable shaft run-out, which leads to leakage and sealing malfunctions. Freudenberg has the right recipe to keep the phenomenon in check: Radiomatic HTS II EWS (EWS stands for shaft run-out). This innovative Simmerring absorbs kinetic energy and is the only **PTFE⁴ shaft sealing ring** with a flexible bellows element. Its seal lip does not lift away as its counterpart does in normal PTFE shaft seal rings, thus providing greater durability. Like the standard Simmerring Radiomatic HTS II, the new shaft seal

stands out for its unrivaled, low frictional values, a design with little gap and dead space, and a homogeneous PTFE surface, which is also resistant to abrasive media. Another crucial advantage of the HTS II is the use of machining in its manufacture. This makes it possible to accommodate special solutions individually. For example, Freudenberg has developed a separable version of the lip seal for amixon's precision mixer, enabling the existing stuffing-box seal to be replaced without dismantling the transmission.



¹FKM: fluorocarbon rubber, ²NBR: nitrile rubber, ³EPDM: ethylene propylene diene monomer, ⁴PTFE: polytetrafluoroethylene



INNOVATIVE SOLUTIONS

MOBILITY – LOW FRICTION AND
ECONOMICAL GOING FORWARD

Downsizing, weight reduction and the minimization of friction – all current trends in the auto industry – are conserving resources and reducing CO₂ emissions. The same is true for pneumatic systems, which are used in seats and gear-shift systems, among other areas.



D-JACK REDUCES
FRICTION

In dry-lubricated, linear-guide pneumatic systems, low breakaway torque is the key to precise control. At the same time, engineers are left scratching their heads over hysteresis effects, whereby a piston never returns precisely to its starting position after a movement. The **D-Jack** offers a solution: Its PTFE layer is firmly bonded with an elastomer. This sealing ring is notable for its extremely low friction, which has a positive effect on hysteresis. It reduces

breakaway torque and leads to a reduction in malfunctions resulting from gap extrusion. The D-Jack has already been tested in promising field trials with a major automaker. The integration of functions into the sealing element leads to advantages for installation space and economical component use.



CURVE GASKETS – THE
PERFECT WAVE FOR
PRESS-IN-PLACE

As part of the continuing search for reduced material usage without a loss of performance, Freudenberg Sealing Technologies has developed a new solution for “press-in-place” gaskets. The unique design of the curve gaskets patented across Europe enables our customers to achieve a perfect seal while also using less material. At the same time, the overall weight is reduced. The curve gasket with undulated cross



section achieves lower counteracting forces, but retains the customary tightness and durability of the Freudenberg seals under extreme conditions.



GREATER SAFETY FOR
INNOVATIVE BATTERY
SYSTEMS

Whether hybrid powertrains, range extenders or completely electrified vehicles, lithium battery systems are increasingly taking hold in auto manufacturing – but they pose new challenges for seals. The reason is that advanced lithium cells are mounted

in flexible envelopes (pouch cells) because the thickness of their cells varies according to the charge level. The Freudenberg frame gasket – for which a patent has been filed – combines the fastening and sealing of individual cells. It puts less stress on the sensitive sealed seam of the cell than a conventional metal frame does, contributing to the cell’s impermeability over many charging cycles. The design of the cell frame gasket also allows the integration of thermal management elements. Still more new ideas for securing innovative energy storage systems are coming from the company’s Innovation Center in Weinheim. The destruction of the battery housing can lead to the release of gas. Pressure escapes into the battery housing and

must be released quickly. To this end, Freudenberg specialists have developed an elastomer pressure relief valve, which opens at a specified pressure. The valve has a fastening element on the battery housing, ensuring that no parts come loose. It meets protection class IP 67, which is required for automobiles.





INNOVATIVE SOLUTIONS



**PNEUMATIC DRIVES –
NEW RECORDS WITH
A DIVISION OF LABOR**

A division of labor can significantly improve performance. This applies to production processes as well as seals. With the **T ring**, Freudenberg engineers have taken a radically



new path in the sealing of pneumatic drives. Dynamic and static sealing duties have been separated in the patented T ring. As a result, it has set new records for friction, wear, installation safety, sealing effects and the bridging of tolerances. A large-radius sealing area handles dynamic sealing. A thinner area constructed like a membrane takes care

of the static sealing function, generating sealing power with applied pressure alone. The T ring sets new standards when it comes to the minimization of friction – 40 percent less than in current seals. In endurance tests, it showed no appreciable wear even after 15 million piston strokes at a pressure of 10 bar. Thanks to its ingenious geometry, it does not need to be pressed into the piston's installation space. This is es-

pecially important for small sealing rings, since they react more stiffly and less flexibly to deformation. In contrast, the T ring shows its outstanding characteristics even in small pneumatic cylinders, which makes it even more attractive given the trend toward smaller installation spaces. It is currently being tested in hammer drills, for example.



**INNOVATIVE SOLUTIONS
FOR STEEL-PLANT
EFFICIENCY – AN
INSTANT, TAILORED
SOLUTION**

Speed in service and repair work is a top priority for steel plants. The reason is that stoppages or malfunctions do not just cost money; depending on their duration, plants have to be completely ramped up again. To ensure the replacement of seals in the giant rollers within 24 hours, Freudenberg has developed an innovative seal ring for diameters ranging from 200 to 1,000 mm: the **Radiamatic RPM 41 radial shaft seal ring**. Every diameter is available thanks to a precision joining process.

Freudenberg Sealing Technologies' cutting and joining technology allows fast service – not least of all because the mold pool needed for base rings and for a variety of profiles can be reduced to less than 100 tools. This decreases warehousing and dispenses with the need for time-intensive machining of new tools when sizes are missing. The joining process by

joint vulcanization is so exact that the joint can barely be distinguished visually from the base material. The Radiamatic RPM 41 does not require a leader element on the seal lip, which facilitates handling, improves the mounting process and



increases reliability. This has been made possible by a newly developed high-performance material (nitrile butadiene rubber - NBR). The material even exceeds the required operating life of three to 12 months, improving a steel plant's efficiency. The Radiamatic RPM 41 combines fast availability with extremely high operating efficiency. It is already in use in German and American steel plants.



**FOR RENEWABLE ENERGY – LONG LIFE
IN THE STORMY HEIGHTS**

They must be impervious to storms, rain or ice and, if possible, run for decades without service interruptions. Those are the demands placed on wind power facilities. Sealing the main bearings of the rotor shaft, in particular, poses huge challenges – and requires in-depth expertise. The reason is that tests and trial runs are almost impossible due to the seals' enormous sizes, ranging up to 3.5 meters in diameter. Freudenberg Sealing Technologies' new **Merkel Radiamatic R 55** has an integrated deflector lip to protect against environmental influences. It also renders the previously essential second seal superfluous.

Besides the cost savings from the use of just one seal, this solution also has in its favor a substantially smaller installation space, with no compromise in functionality. The Radiamatic R 55 can even compensate for radial clearance or eccentricity in the shaft, without neglecting its sealing duties or leveling function. And Freudenberg developers were even able to efficiently block the risk of

increased wear from vacuum formation between the seal and deflector lip by using a textured lip. This gives the Radiamatic R 55 everything it needs for a long life in the stormy heights.



NEW PU GENERATION



IT COMES DOWN TO THE MIXTURE

FREUDENBERG SEALING TECHNOLOGIES IS INTRODUCING A NEW GENERATION OF POLYURETHANE — A SEALING MATERIAL THAT SETS NEW STANDARDS.

Dr. Jürgen Hieber loves solving puzzles. At the Schwalmstadt plant, the Head of Materials Development for seal-maker Freudenberg Sealing Technologies, worked on new recipes for three years before finding the right mixture. He is now certain, "Our new generation of polyurethane is setting new standards." Polyurethane is primarily known as foam for door frames and mattresses, although it is also frequently used in paints and adhesives. Otto Bayer developed polyurethane in 1937, and it soon made its triumphant way around the world. About 12 million tons are processed annually, and about 5 percent is used in mechanical components. In keeping with the slogan "seldom seen, mostly indispensable," polyurethane is important for the production of seals that perform their tasks under especially se-

vere conditions. Along with excellent resistance to ozone, it has four times the wear resistance of elastomers. It also effectively withstands exposure to mineral fluids.

ABOUT 40 YEARS AGO, FREUDENBERG ALSO SET NEW STANDARDS

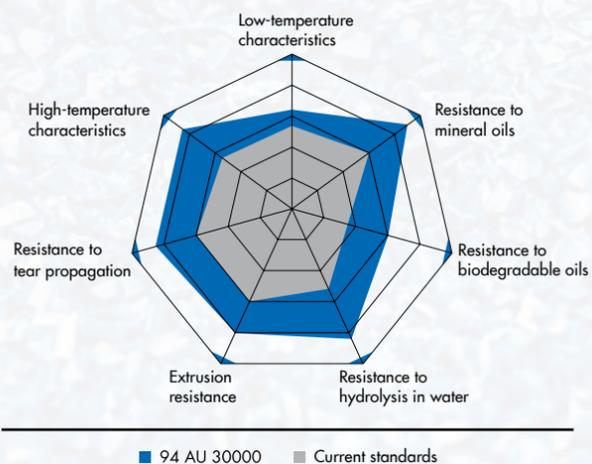
when it brought out a polyurethane material for its high-performance seals. "We invented it," Freudenberg men and women still say proudly when talking about this material, which is used especially in seals for heavy-duty machines such as excavators and tractors. The mixture, which is at least as secret as that of any American soda, has been

repeatedly refined and adapted to the needs of the market. Now, one of the company's core competencies has come to the fore again – the development of its own materials. "We produce the base materials for our seals ourselves, so we are not dependent on suppliers," said Mathias Burkert, Head of Product Marketing at Freudenberg Sealing Technologies in Schwalmstadt. Freudenberg succeeded in manufacturing a material with a much longer service life than materials used to date.

THE NEW GENERATION OF POLYURETHANE

was developed for a wide array of uses. The new standard material is more resistant to water and

NEW GENERATION OF POLYURETHANES



withstands major temperature fluctuations. The usage spectrum ranges between -40°C and $+120^{\circ}\text{C}$. This was made possible by a specific modification of the PU components responsible for its temperature characteristics and resulted in the PU material's particularly favorable viscoelastic behavior. In practice, this means that seals made from the material stay flexible at low temperatures and sufficiently stable at high temperatures.

In this way, development engineers take changing market requirements into account. The new generation of polyurethane seals is especially well-suited to construction and agricultural machinery, as well as materials handling equipment. Operators in these sectors are increasingly turning to leased equipment. Leasing involves longer machine operating times than would be case for exclusively owned equipment. Leased machinery therefore requires high-performance materials that allow far longer periods of operation. "We have achieved the objectives of being more robust and lasting longer," Burkert said.

THE MARKET ALSO EXPECTS GLOBAL SOLUTIONS.

New designs require the use of common parts that are universally applicable and help to reduce costs. As a universally applicable material, the new polyurethane generation meets these requirements. Until now, manufacturers have often had to store different versions of components, such as hydraulic cylinders, depending on where they are used globally and the

medium in the hydraulic system. "Today, construction machinery is being developed for worldwide use," said Burkert. "Seals must perform their functions in the desert as well as the Arctic reliably year-in and year-out." The new generation is designed specifically for these demands. India is one example: High temperature differences and inadequate maintenance lead to early component wear there. "Hot days and cold nights can quickly bring a seal to its limits," Hieber said. Machine malfunctions and their high associated costs are the result. The innovation from Schwalmstadt can help companies avoid them. "This is a true cost benefit for our customers," Burkert said.

"THE NEW MATERIAL IS SUPERIOR TO OTHER POLYURETHANES IN ALL RELEVANT AREAS,"

said Hieber, who has worked at Freudenberg since 1996. It outperforms them in heat and cold, can be used in mineral hydraulic media up to 120°C , and is safe from damage due to hydrolysis, even when used in water heated to 80°C . While normal standard polyurethanes often give up after several months of operation in these conditions, the new mixture lasts many times longer and ensures the capacity of the equipment to do its job. But the material is also a genuine high performer when it comes to pressure. In a comparison test with various extrusion gaps at 40 megapascals and 100°C , seals with the new generation of polyurethane showed no appreciable sign of wear, while conventional seals malfunctioned early. Its tensile

strength also far surpasses current possibilities, measuring around 25 megapascals, or 35 percent, above other materials.

"AS A RESULT, WE CAN APPLY MUCH MORE PRESSURE ON THE CYLINDERS THAN WE COULD PREVIOUSLY,"

Hieber said. Experts at Freudenberg Sealing Technologies were able to double extrusion stability under high pressures. This ensures the avoidance of damage from any pressure peaks, of the kind particularly evident in highly stressed equipment such as construction machinery.

This is good news for the sealing specialist's customers. They can rely on a product that meets the highest technical demands and allows long, maintenance-free operating cycles — under the world's toughest operating conditions. "We expect our product to last three to four times longer than the others," Hieber, 48, said. He considers the new polyurethane generation to be a milestone in the history of Freudenberg Sealing Technologies. The Weinheim-based company is banking on the success of its own research. Next spring, a new production facility will go into operation in Schwalmstadt with a total investment of more than 4 million euros.

It also successfully closes an important chapter for Hieber. "This is something you do just once in your lifetime," the chemist said. But he is certain the new material will set a new industry standard for years to come.



POLYURETHANE GENERATION

DR. JÜRGEN HIEBER

The life's work of an inventive mind. The Doctor of Chemistry spent three years researching the new generation of polyurethanes. The 48 year-old has been a materials specialist at Freudenberg Sealing Technologies since 1996. "This is something you do just once in your lifetime. We are setting a new industry standard with the new generation of polyurethanes."



WELDING INSTEAD OF STAMPING

NEW AWARD-WINNING MAGIC FORMULA FOR RESOURCE-CONSERVING, SCRAP-FREE PRODUCTION

It was long a thorn in the side of Dr. Arman Barimani: In the stamping of support rings for Simmerrings, a large portion of the valuable steel piled up as scrap. "Absolutely unsatisfactory ecologically and economically," said Freudenberg Sealing Technologies' Chief Technology Officer. The company produces around 200 million Simmerrings annually for 3,500 different applications in the automotive, electrical and chemical industries, as well as in manufacturing systems. However, Barimani could not let go of one idea from an employee in the 1990s: Don't stamp – weld. Working with Trumpf Lasertechnik and Otto Bihler Maschinenfabrik, Freudenberg Sealing Technologies developed a completely new process from the patented basic idea: SUL, laser-welded narrow-band forming technology. "This technology, which is unique worldwide, allows a rate of material usage of nearly 100 percent. That means we can reduce the steel consumption by 73 percent," Barimani said proudly. The first SUL

system went into operation in 2010 in Weinheim, with an investment 3.4 million euros.

HIGHER QUALITY – SHORTER PRODUCTION TIME

Instead of a broad steel band, only a narrow band is used. It is rolled over roll bending units, sectioned by a laser into the desired size and welded by the CO₂ laser directly to the ring. Then the individual steel rings are fully automatically border crimped, profiled or chamfered in a single continuous operation, depending on the technical specifications. Up to 44 support rings leave the installation ready-finished per minute – with a substantially higher quality and precision than with conventional stamping processes. Various ring sizes with diameters ranging from 9 to 400 mm can be produced – with lower tooling costs and shorter sampling times. Shorter

production times and greater flexibility drastically reduce time-to-market.

SYMBIOSIS OF ECONOMY AND ECOLOGY

Environmental performance is just as impressive: The new SUL system saves 1,800 tons of steel per year, reducing CO₂ emissions by about 2,700 tons. Less merchandise and scrap transport also cuts CO₂ emissions. Furthermore, the production process does entirely without drawing oil, thus dispensing with the need for chemical cleaning agents. The extraordinarily high quality and precision of the sheet metal rings during further processing of the seal also make it possible to use less elastomer material. In addition, the SUL technology makes considerable progress in occupational health and safety. The installation operates much more quietly than a stamping process, and the use of heavy tools is eliminated. The danger of cut wounds is also considerably lower.



DR. ARMAN BARIMANI



"SUL technology sets an example by combining economic with ecological and social sustainability. It represents a long-term orientation with sustainable outcomes and perfectly illustrates the thinking and action of our family-run company," Barimani said. He is especially proud of the fact that this groundbreaking process innovation has already won three prestigious awards: The "German Innovation Prize for Large Companies" and the "German Innovation Prize for the Climate and the Environment" in 2011; along with the "Manufacturing Leadership 100 Sustainability Award" from the Frost & Sullivan Manufacturing Leadership Council in the U.S. In coming years, Freudenberg Sealing Technologies will invest in more SUL facilities. CO₂ emissions and the consumption of resources will decline further as a result.

SAVINGS IN THE COLD RUNNER

In elastomer production, too, Freudenberg Sealing Technologies is turning to a process that conserves resources and reduces scrap. In the conventional injection molding process, the sprue screen produced a large amount of scrap. Post-heated elastomer cannot be recycled. "Depending on the diameter of the Simmerring, up to 60 percent of the material ends up as scrap, including expensive FKM. That is pure waste," explains Thorsten Stickel, Head of Process Technology in the Lead Center Simmerring In-

dustry and CC Transmission & Driveline. Since 2009, the Lead Center has functioned with a newly developed cold runner technology, through which the material is sprayed into the form, dispensing almost entirely with the sprue screen. The result is an accumulation of just 7 grams of scrap per ring, instead of an average of 45 grams. "We are seeing a savings potential of 30,000 kg per year for our Lead Center, in particular for the expensive FKM," Stickel said.



PILLOWS FOR PORPOISE EARS

It is the smallest porpoise and the only one in the North and Baltic seas – the harbor porpoise, which grows to a maximum of 1.8 meters in length. The population is in decline. These marine mammals are now highly exposed to noisy underwater construction for offshore wind parks. It is driving them from their ancestral habitats near the coast. An innovative sealing system from Freudenberg Sealing Technologies Merkel has succeeded in creating a kind of protective acoustic wall around the source of the noise and significantly reducing its level.

Wind power is one of the pillars of the much-coveted energy transition in Germany. In the North and Baltic seas, about 2,500 wind turbines are due to be built in 40 offshore parks. An offshore transformer station “collects” the electric power generated by all the turbines in a wind park, transforms it from alternating current of 30 kilovolts (kV), for example, to a voltage level of 155 kV, and “passes it on” to a converter station. From there,

the electric current is transported over a distance of perhaps 160 km to land. Foundation piles are driven up to 40 meters into the sea floor. This is incredibly noisy to the harbor porpoise. These small porpoises have a very sensitive sense of hearing, using it to communicate, orient themselves and hunt. Like bats, they “see” with their ears. With the help of a sonar system, they send out ultrasound signals and acquire an acoustic image of their surroundings from the echoes. If the environment is too loud, they lose their bearings and retreat to another area.

NOISE REDUCTION FOR GREATER QUALITY OF LIFE

“The protection of climate and nature must not contradict one another,” said Jens Kuhnert, Project Manager at Freudenberg Sealing Technologies Merkel. Together with his team, he

developed a sealing system for an innovative process to reduce noise during pile driving. The so-called air-cushion process was proven to be the most effective and economical in a test of various noise remedies.

The principle is simple, but the demands on the seal are huge. The pile to be driven is enclosed in an empty tube with a diameter of about 2.5 meters. In a triple configuration, the specially produced sealing rings close the gap between the pillar and the outer tube. In this way, air can be forced into the intermediate space, displacing the water there. The resulting cushion of air decouples the acoustic source from the water. In the process, the sealing system withstands a pressure of up to 6 bar and deflections in the seal gap of up to +/- 25 mm.

The result is that the pile drivers strike far more softly. “That’s clearly a great relief to the porpoises. In this way, we can give them back some quality of life in their ancestral home,” Kuhnert said with satisfaction.



COWSHEDS GET ENVIRONMENTAL MAKEOVER

“Milk gives tired guys a lift,” according to a 1950s-era advertising slogan from the German dairy industry that is still often quoted today. But what cows give to the environment is anything but uplifting. Methane escapes from their front end, damaging the climate, while the greenhouse gas CO₂ and toxic ammonia are discharged from the rear, irritating mucous membranes and respiratory passages. In concentrated form, ammonia can even be life-threatening. Gaseous ammonia is released as liquid manure decays. Special slatted floors with rubber inlays from Schneegans-Freudenberg prevent the further generation of unhealthy ammonia emissions in the cowshed. The rubber profiles immediately drain the liquid manure into a gutter running under the floor. Then modular sealing shutters close off the gutter and shut out the foul-smelling mixture. The cows not only benefit from a more comfortable environment in the stable, their risk of injury is less with the combined concrete-and-rubber surface of the slatted floors compared to purely concrete slats.



NEW SEAL SOLUTION FOR SOLAR MODULE CONNECTOR

Plug connection systems and seals for solar modules should perform their tasks unobtrusively and reliably for at least 20 years. But they are often exposed to extreme stresses – for example, in the salty, humid air near the sea. Yet resistance to ammonia-filled air has emerged as one of their most difficult challenges. So far, this particularly aggressive environment has troubled seals used in plug connectors on the roofs of cowsheds. Freudenberg Sealing Technologies has developed a new, robust sealing system for this application. It guarantees the high protection classes IP65, IP67 and IP68 (1h/1m). The German Agriculture Society says it is convinced and has attested to its long-lasting resistance to ammonia.





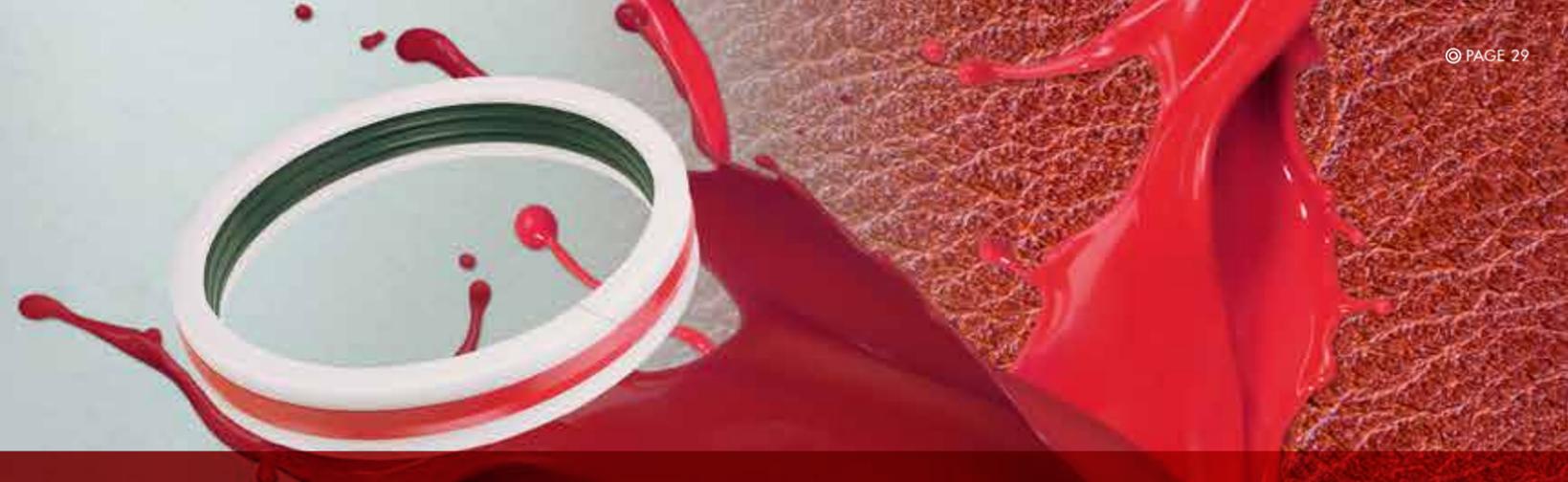
THE UNCONVENTIONAL THINKER

DR. PETER KRITZER IS RESPONSIBLE FOR
DISCOVERING INNOVATIVE APPROACHES

DR. PETER KRITZER

IS ATHLETIC. BUT THE GROUP MANAGER FOR ADVANCED Product Technology at Freudenberg Sealing Technologies doesn't go to sports equipment fairs to seek out the newest ski boards or wakeboards for his next vacation. He looks instead for new trends and solutions on foreign soil. And he indulges his proclivity in places where you would not necessarily expect to find those trends, at least from the standpoint of a seal manufacturer.

DETOURS ARE TYPICAL OF
THE 44 YEAR-OLD'S APPROACH.



WHY A SPORTS EQUIPMENT FAIR OF ALL THINGS?

Kritzer, a PhD chemist, responds with an enigmatic smile. "You have to take a broader view," he said, justifying his side trip. "I just might discover a cross-country ski with a new, original coating that we can learn from. The reduction of friction also plays a key role here."

Kritzer has been in charge of finding innovative approaches at Freudenberg Sealing Technologies since 2007. This is a task of more than just personal importance; innovations are crucially important for companies that live and breathe their materials expertise and want to always be a step ahead of their competition. In his professional career, Kritzer has come to realize that the right environment is a priority.

After his studies in Heidelberg and an interdisciplinary PhD in Karlsruhe, he took a job at an American computer manufacturer. The trips between Germany and Silicon Valley left an enduring mark on Kritzer, who was then almost 30. "I started out as a process engineer for micro electroplating in advanced development," he recounted. "We had amazing working conditions, an ample budget and plenty of freedom to try things out. But every time we wanted to bring one of our products out of advanced development and into series development, we ran into a brick wall." Departmental thinking and the "not invented here" mentality troubled the young chemist. "There was no connection between advanced and series development," he said. "New developments that could not be integrated into standard processes had no chance of realization." So he left the company after just under two years; just a few years later, the firm had to give up its manufacturing division. It missed out on important innovative leaps in the market.

The Mannheim native has had a completely different experience at Freudenberg nonwovens since 2000. "Here I was virtually commanded to think laterally," he said, describing his role right from the start. "But considerable value was placed on networking in particular." The direct contact with customers and suppliers was a new experience for him. His area of activity was the development of battery separators and their application technology. Besides the core business with conventional technologies, he was also in charge of establishing Freudenberg in the growth market for lithium batteries.

At the outset, it wasn't that simple to motivate people to collaborate on new types of batteries. Among other things, pictures from an electron microscope proved helpful. "Many people were inspired by the beauty of the structure of these newly developed separators," he recalled with a smile.

HE CONSIDERED THE INTEGRATION OF ALL PARTICIPANTS TO BE A MAIN RECIPE FOR SUCCESS.

So the team always made sure that the people who helped make a project a success could always find their names on patent filings or in publications.

The experience with customers and suppliers sharpened Kritzer's awareness of the nature of innovation. "I noticed that a question about our customer's technical problems can quite frequently be the first step to igniting a completely new idea," he said. In the process, it helped to have a very broad-based company like Freudenberg backing him up. "The right solution was usually found in some corner of our diversified company."

"THE TRICK WAS OFTEN TO BRING THE TWO SIDES TOGETHER AND TO CONNECT THEM IN A CREATIVE WAY."

The process of innovation at Freudenberg Sealing Technologies has been deliberately promoted since 2006. A multistage process (known as the product innovation process, or PIP) was developed; it regularly evaluates and scrutinizes projects and innovations. The goal is to focus available resources and to carry the projects into series products as quickly as possible.

Back to finding ideas: Twice a year, the F.A.Z. Institute sends out invitations to workshops at Freudenberg, and participants from a wide array of sectors have registered for them. However, it is not just the Freudenberg innovation philosophy that emerges from the orange-gray seats in the creative space at the Innovations Center. "It is especially important to us that we apply and demonstrate problem-solving technologies in concrete cases," Kritzer said. "And that happens so convincingly that some new Freudenberg projects have already emerged with the participating firms."

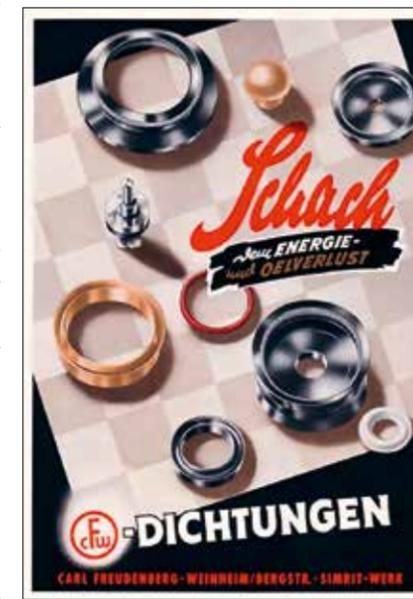
But can innovation or creativity really be learned? For Kritzer, it is a difficult question. His motto is, "If you want to be creative, you need to have a consciously open mind for new things." And the capacity to tie things together theoretically even if they do not seem to have much to do with one another at first. "Outside-the-box" thinking is indispensable. "This applies to the composition of teams or workgroups, as well as to the project manager who is working on a solution to a problem. As an individual, I have to open up to influences – including those from areas that are entirely different from my own: from the day's events, my hobbies, what my children are telling me.

The crucial idea can come from anywhere. And it is important for groups to have an interdisciplinary basis so they can look at a problem from several perspectives."

KRITZER SEES OUTSTANDING EXAMPLES OF INNOVATIONS IN FREUDENBERG'S HISTORY.

In the 1930s, the Weinheim-based company was the largest tannery in Europe. Like all industrial operations of the time, the company had enormous problems with seals for its machines. The creative contribution of engineer Walther

Simmer was to design sealing rings for drive shafts made from leather scrap – initially only to gain control of sealing problems in the company's leather processing. But it worked so well that a new business field was identified through the sale of these leather sealing rings. With the result that the leather scrap was no longer sufficient to meet the company's needs and a substitute



CARL FREUDENBERG
Advertising flyer for seals from 1955



had to be found among the new, synthetic elastomers just reaching the market. The Simmerring was born and, in the process, a new industrial standard and a success story unparalleled to this very day. At first, existing products – leather components – were carried over to a new application – seals. In a second step, there was a change in materials – to the elastomer seal.

What can you learn from this more than 80 years later? “You have to give creative ideas the space they need,” Kritzer explained. “It is important to let people try things out and give them time and resources, even if it’s not always clear whether the planned goal can be reached. Without this leeway, creativity is bottled up and innovation is impossible. The leap from leather producer to seal manufacturer would not have been conceivable without the intermediate step of the leather seal.” But in each case, a defined process is needed that allows the projects to be scrutinized repeatedly at a later stage. It is also important to integrate colleagues from series development, and this is where Kritzer’s experience during the early years of his career comes into play.

Translated to the professional environment of the 21st Century, this means that

“CREATIVITY NEEDS TRUST,”

according to Kritzer. And increasing openness. “It is important to define one’s own self-concept. There is a difference in whether I see myself as a seller of sealing rings or a problem-solver for transmission manufacturers.” He has an up-to-date example of this: “You can only arrive at the idea not to use a membrane in the cover for transmission ventilation and use a nonwoven instead – provided that you see yourself as a problem-solver for your customer. You think



in networks, so you might look for the solution in a totally different area of the company.”

Kritzer also believes it’s important to have a personal reset button. “If you’re always thinking about the job, you will be blind to different ways of doing business and closed off from information,” he said, stressing the importance of a work-life balance. His activities include riding lessons with his wife and daughters and an annual smartphone-free vacation on Amrum Island. “In the process, it occurred to me that the issue of ship emissions has continued to be neglected. And after my vacation, we immediately formed an interdisciplinary brainstorming group, where we consider whether we might develop potential from this ...”

TROUBLESHOOTING AROUND THE GLOBE

FREUDENBERG XPRESS

THE E-MAIL REACHED HOLGER STANNEK
AT 9:30 A.M. ON A WEDNESDAY MORNING.

There was water penetration overnight on a lighting mast on a mega-yacht whose owner did not want to be named. A North German company that had installed the mast on the ocean-going yacht was obligated to honor a warranty, and the ship was supposed to put to sea as soon as possible. But this was only possible with a functioning lighting mast.

IT WAS JUST THE JOB FOR FREUDENBERG XPRESS.



FREUDENBERG XPRESS

The troubleshooting department at Freudenberg Sealing Technologies is tremendously well-suited to such specialized tasks.

SPEED, SHORT ADMINISTRATIVE PATHS AND YET EXTREMELY HIGH PRECISION

are the qualifications for solving sealing problems in industrial equipment or prototypes on short notice – from Schwalmstadt in Germany, to Diadema in Brazil, all the way to Gurgaon in India. Or even on megayachts. The assignment may require work on site. On the mega-yacht, the key was to figure out whether the seal could not keep water out because of a weakness in its design, or was it improperly installed? Or just defective? Stannek was on board the next morning to get an impression.

One thing was quickly apparent: No one should have expected the seal, which a materials-handling company had installed, to function reliably. Greater pre-tensioning would have solved the problem, although this execution was not available for the dimensions involved. That was no problem for the “first responders” from Freudenberg Xpress. The turning of single seals is part of the Schwalmstadt service center’s core competency. By Friday morning, the drawing for the urgently needed individual seal was ready. The Xpress specialists can juggle

100 PROFILES MADE FROM 20 MATERIALS

and find the right answer to just about any sealing challenge. The lathe was running Monday morning in Schwalmstadt and the wip-

ers were already at the customer on Tuesday. “We don’t always get direct feedback in such cases,” Stannek said. “But in this case, we received a call a day later saying that everything was holding tight in a test on Wednesday.” The yacht was able to put to sea.

The projects arriving at Freudenberg Xpress by fax or mail are not always as spectacular as a mega-yacht. But they always involve extreme urgency and, often enough, the high costs of machine downtime. A quick repair ought to minimize them. Take the case of the steel producer with an adjustment cylinder at a hot rolling mill threatening to malfunction. Two wipers were damaged – the report went out to Freudenberg Xpress on a Tuesday afternoon. Two days later, the new wipers arrived at the steel plant. The hot rolling mill had made it that long. Expensive downtime and a protracted production re-start were barely avoided.

FREUDENBERG XPRESS

PRECISION MACHINING AGAINST THE CLOCK:

Using 100 profiles and 20 materials, Freudenberg Xpress specialists can make seals of all sizes that are not available off the shelf – if necessary, within 24 hours.



NOT JUST REPLACEMENT – CREATIVE SOLUTIONS ARE IN DEMAND

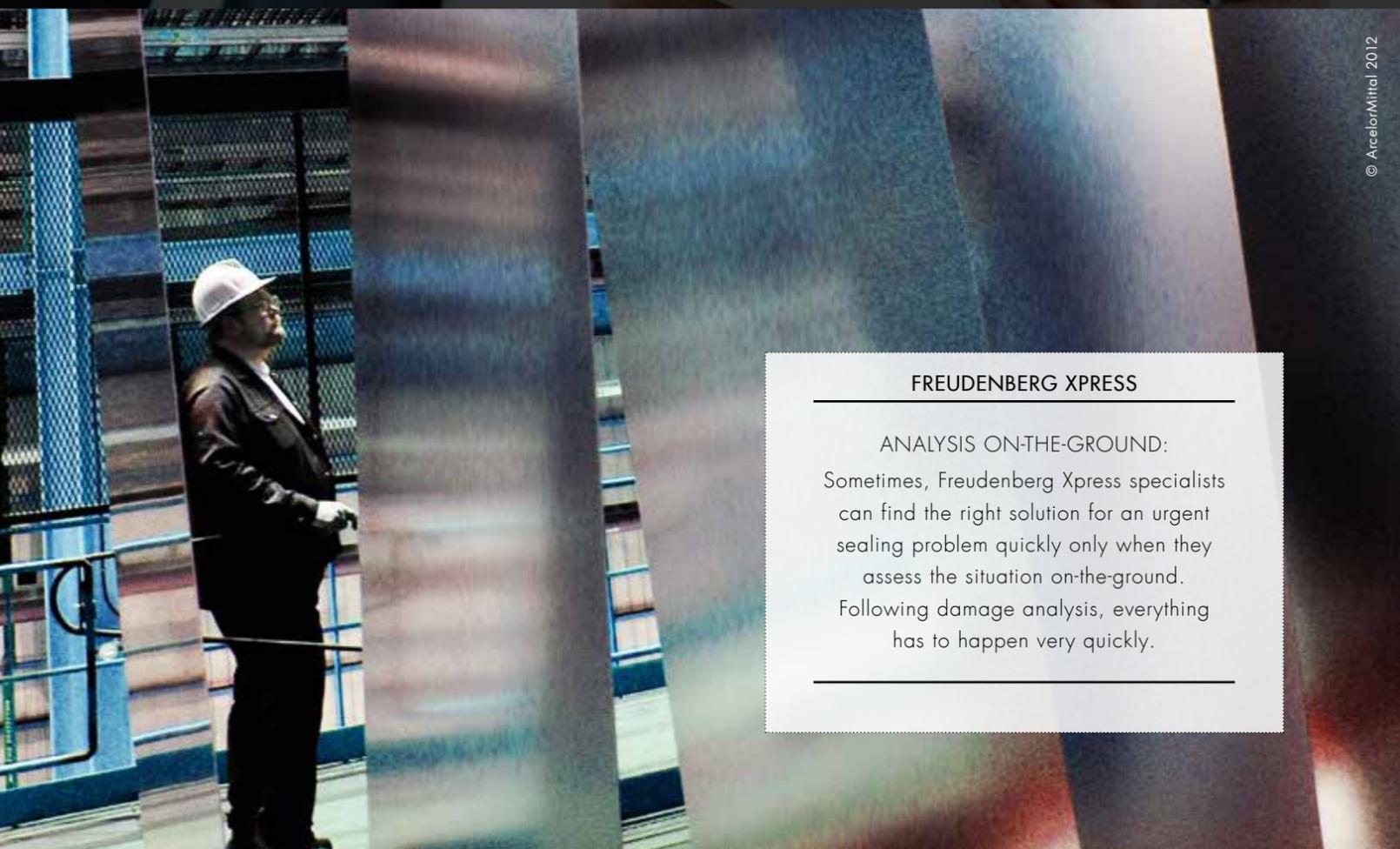
Sometimes, tight time frames require creative solutions: On one occasion, shaft sealing rings were delivered so that the shaft of a paper mill would not have to be dismantled. The shaft sealing rings were conceived only as an emergency solution. But calls to the customer revealed that the temporary seals handled their job for weeks to everyone’s full satisfaction, so they should just stay on the shaft.

THE ENGINEERS ARE ESPECIALLY PROUD

when they manage not just to replace but to improve a sealing system. Consider the case of Sparrows Point, the largest and oldest steel plant in the United States. An out-moded sealing system close to a bearing unit was leaking considerably. A newly designed sealing system was Xpress-manufactured without further ado. Since then, it has saved 10,000 gallons in leakage losses per unit. Stefan Bösenieilers at the Freudenberg Xpress branch in Milan, Ohio, considers the assignment a highpoint. “The benefit

to the environment and the savings from the reduced leakage impressed the management. We were able to equip another four steel plants with our Xpress solution immediately afterwards.” In fact, those responsible for the U.S. market can show numerous examples where the Freudenberg Xpress rapid intervention force has optimized existing sealing systems. For example, it was possible to add six months to the operating life of the seal on a high-pressure vessel that previously had to be replaced after a maximum of one month. The same was true for a seal on a hydraulic hammer on an earth mover used in road construction. It, too, had required new seals every month. The Freudenberg Xpress experts in Milan, Ohio, were also able to put a hydraulic press back into operation in 24 hours with the help of a new sealing concept. And the largest American producer of seamless pipes was happy not only with the leak repairs on his rolling mill after a Freudenberg Xpress visit, but with the \$250,000 in savings as well – and that’s per month! Freudenberg employees in Diadema can also highlight successful inter-

ventions. Manager Juliana Matos is proud of the fact that the maintenance interval for seals in a press used for piston manufacturing at Mahle has been increased tenfold – without leaks during operation. Sometimes Freudenberg Xpress experts are booked for assignments that are far removed from heavy industry and mega-yachts. Manfred Sack, Marketing Manager in Schwalmstadt, can recall a special case: “One day before an important trade fair, a Swiss maker of automatic coffee machines had a seal malfunction on an important new model,” he said. “We had the right material available requiring (FDA) approval for use in the food industry and immediately machined a seal with a 12 mm diameter that could be installed by the start of the fair.” Simone Spirig-Hallauer, who received the customer’s distress call, was no doubt gratified that unusual assignments sometimes bring unusual responses in their wake. The maker of automatic coffee machines thanked her for the help with a bouquet of flowers.



FREUDENBERG XPRESS

ANALYSIS ON-THE-GROUND:

Sometimes, Freudenberg Xpress specialists can find the right solution for an urgent sealing problem quickly only when they assess the situation on-the-ground. Following damage analysis, everything has to happen very quickly.



RICH SPOILS WITH LEAN METHODS

ITALY

THE BEATING HEART OF THE VALVE-STEM SEALS BUSINESS IS IN ITALY.

In the peaceful town of Pinerolo, near Turin, the Lead Center for valve-stem seals produces about 330 million units a year. That is 70 percent of all the valve-stem seals in the European market. They are made with the help of robots. This Freudenberg Sealing Technologies Lead Center is the first manufacturer to fully automate the post-curing process for these elastomer seals.



“TEN YEARS AGO, WE PROVED THAT IT IS POSSIBLE TO USE ROBOTS IN SEAL PRODUCTION,”

said Dr. Claudio Zoppi, who has led the Lead Center for valve-stem seals since 2000. He is an ardent champion of the Freudenberg philosophy of lean, environmentally friendly production processes – and the Genba walk. With “an eye for lean,” the 53-year-old regularly walks through production areas, making precise observations and opening his mind to new ideas for reducing production times and environmental impacts.

In 2003, when Zoppi became familiar with automation projects at an IT company in Mannheim, the potential for robotic applications immediately inspired him. He and his team quickly looked at their suitability for the production of valve-stem seals. The Italian team developed the first flow production from the press all the way into the post-heating oven. Robots have taken over the routine tasks in the new closed installation.

ROBOTS HEAT THINGS UP

Like nearly all elastomer seals, valve-stem seals have to be post-heated after forming. In doing so, workers have customarily taken the finished parts out of the press individually, placed them on post-heating carts and moved the carts into large, centrally located furnaces. The seals remain there for several hours at more than 200° C before being collected again. “This is non-value-added and phys-

ically strenuous,” said Zoppi, who started in 1985 as a sales engineer.

In the new procedure, robots “sit” at the press. They lay the vulcanized sealing rings on a conveyer, and move the parts into the new furnace, which is connected directly to the line. There the seals are slowly moved in a spiral and automatically conveyed out.

The system offers a wide variety of benefits – for employees, customers and the environment. “Thanks to the closed concept, it is no longer necessary to open the oven doors and push large, cold carts inside,” Zoppi explained. “This means we can maintain a constant temperature.” Energy consumption is reduced by 20 percent and throughput times by 55 percent. “Our employees are spared up to 8 km of strenuous walking a day. That means they can devote their energy and time to value-added tasks,” said Zoppi, an avid keyboard player and indoor cyclist.

Today 13 robots work in Pinerolo, and 30 percent of production has already been converted to the new process. “Every time I walk through the manufacturing area and see how smoothly our robots work, I am just as impressed as I was 10 years ago,” Zoppi said. Now he wants to establish this sustainable production process as the standard for valve-stem seals worldwide. And he is already tackling his next project to “slim down” operations: an automated line for blanks preparation for Transfer Ready Molding, which will reduce use of material by 50 percent.



ITALY

THROUGH AUTOMATED POST-HEATING energy consumption has been reduced by 20 percent and throughput times by 55 percent. Furthermore, the 13 robots save employees from walking up to eight kilometers every day.

MORE ROOM FOR GREATER GROWTH

The plant in Pinerolo has been the Lead Center for valve-stem seals since 1992 – for the European market until 2011 and worldwide thereafter. The Italian firm started production of these seals in 1959 as Corcos s.a.s. – initially in close cooperation with Freudenberg and, since 2008, as a wholly owned subsidiary of the Weinheim-based sealing specialist. Corcos has continually expanded its market share over the decades due to its focus on one product, its systematic, ongoing advances and its conversion to lean production processes. Today, this market leader has 180 employees, including 100 in manufacturing and 20 in research and development. Last year, it generated 40 million euros in revenue. The historic factory in the middle of Pinerolo was too small to handle the company’s rapid growth. So in 2009, after 50 years, it moved 2 km away to “La Porporata,” a new industrial zone. At just under 40,000 square meters, the newly built facil-

ity offers more than three times the space of the old facility – and the best possible conditions for highly advanced, environmentally friendly technology. All the plant’s electricity comes from hydropower. Solar collectors provide hot water and office lighting. The heat generated by the water-cooling system serving 43 presses is re-used for heating. The energy savings compared to the old, much smaller facility are enormous. Electricity consumption for lighting has fallen by 10 percent and gas consumption by 40 percent. The decrease for the presses’ water-cooling system was 90 percent. “Overall, the new, brighter and roomier spaces for offices and production are by far a better calling card for our employees and customers,” Zoppi said. “And in the middle of the industrial zone, our trucks pose no danger to residents or pedestrians and create no noise pollution as they come and go.” Asked about his goals for the next five years, the manager with the “lean eyes” doesn’t hesitate for a single second. “An 80 percent market share with the same profitability that we have today. Or better!”



TOGETHER FOR 77 YEARS

The cooperation between Freudenberg and Corcos dates back to 1936, when the Italian company took over sales of Freudenberg products and later their production in Italy. That included the Simmerring, which was sold under the trade name Corteco. The name Corcos is a combination of the last names of company founders Francesco Corte and Lodovico Cosso. Over the decades, the partnership between Freudenberg and Corcos became increasingly close. Freudenberg initially took a 50-percent stake in Corcos, rising to 100 percent in 2008. Besides the global Lead Center for valve-stem seals in Pinerolo, Corcos is responsible for the Lead Center for Simmerring cassette seals in Luserna San Giovanni, among other facilities

DR. CLAUDIO ZOPPI
MANAGER GLOBAL LEAD CENTRE
VALVE STEM SEALS





NEW UMBRELLA BRAND, STRONG PRESENCE

CAMPAIGN

UNIFORM APPEARANCE WITH INCISIVE ADVERTISING THEMES

The new Freudenberg Sealing Technologies brand campaign is presenting strong, catchy, memorable themes. In its public presence, the company is self-confidently displaying its expertise as an innovative leader and provider of sealing solutions and demonstrating that it can find optimal solutions to even the most difficult challenges.

THE CAMPAIGN IS DERIVED SYSTEMATICALLY

from the new brand architecture. Since early 2013, all tasks and activities have been consolidated under the "Freudenberg Sealing Technologies" umbrella brand. "Our external representation was previously complex and non-uniform," said CEO Claus Möhlenkamp, explaining the new strategy. "Clear brand positioning and messaging had become blurred," he said. "As a result, our customers did not sufficiently grasp our overarching strengths as a global company. Our goal was greater clarity for the customer – with a brand and with a promise." Möhlenkamp continued: "Our new brand identity should create internal synergies and promote long-term growth. Wherever our brand is present, it should foster the perception of a global company and innovative leader in sealing solutions for all mobile and industrial applications." What is impressive about the campaign is that it does not necessarily show products but instead visualizes

where Freudenberg Sealing Technologies plays a role around the world. And this includes the most varied areas of application. The themes are shown with different arrangements and a broad array of possibilities – sometimes authentically, sometimes with emotion or simply unseen – stylistically associated with a world that captures the brand's unmistakable quality image. To sharpen the profile of the new brand architecture and convey the associated advantages to customers, the company presents itself openly and transparently. The development of the campaign is the first step toward continual, active communication. Other measures will follow. "We wanted to make it possible to appreciate the special mix of know-how, experience, quality and passion," said Michael Scheuer, Head of Global Communications at Freudenberg Sealing Technologies, outlining the objective. "Whenever it comes to uncompromising quality and reliability in sealing technology, we are the first choice worldwide for a wide variety of different customers in nearly all sectors."

THE POSITIONING THAT THE COMPANY IDENTIFIED

was based on intensive discussions with customers, management and sales staff. "Our products and solutions stand for quality and technology, as well as innovative power and reliability in a wide variety of sectors. We want to translate this in communications that are as purposeful as they are exciting," Scheuer summed up. "In so doing, we have to convey and illustrate the many issues and messages with striking stories." Often invisible, always essential – That is how the positioning translates into a short, incisive claim that will find its way into all the campaign's messages, including advertisements, brochures and online presence. Strong images show confidently and credibly the areas of application where the passion for quality is particularly in demand, ranging from maritime uses and mining all the way to wind power facilities.





LESS THE CO₂ ECONOMY PACKAGE

SUSTAINABLE MOBILITY

DEVELOPMENT DEPARTMENTS ARE WIELDING THE CO₂ AXE AS AUTOMAKERS MOVE TOWARD SUSTAINABLE MOBILITY.

When it comes to cutting harmful greenhouse gases, every gram pays off. Freudenberg Sealing Technologies has developed LESS, a CO₂ economy package that further improves the efficiency of advanced, high-tech internal combustion engines and puts alternative powertrain technology on the fast track.



EVERY GRAM COUNTS

WITH THE DEVELOPMENT OF NEW TECHNOLOGIES, the auto industry has succeeded in cutting the average CO₂ emissions of all newly registered cars in Germany by 21 percent to 137 grams per kilometer in the last 10 years. A remarkable performance since the average engine output of all new cars has risen from 117 to 136 horsepower. And the cars are nearly 100 kilograms

heavier due to additional comfort and safety equipment. Starting in 2015, the fleet average for all newly registered cars in the European Union is supposed to decline further, according to an EU directive – from 130 initially to 95 grams in 2020. This corresponds to the consumption of about four liters of gasoline per 100 kilometers driven. “Not least of all, this is

why it is essential to boost the ultimate potential of the internal combustion engine,” said Torsten Maschke, President, Automotive Sales & Marketing, at Freudenberg Sealing Technologies. He is firmly convinced that diesel and gasoline engines will continue to shape individual mobility for a long time and, as a result, new concepts will be needed to lower fuel consumption and emissions

across the board as quickly as possible. At the same time, various alternative powertrain concepts will become increasingly important.

“As an innovation-driven auto supplier, we have combined our entire materials expertise from all our company areas and have developed targeted solutions that continue to sharply reduce CO₂ emissions from the internal combustion engine, while supporting the development of new powertrain technologies and fuels,” Maschke said. Under the name “Low Emission Sealing Solutions,” or **LESS**, Freudenberg Sealing Technologies has assembled all these product innovations into a single kit.

LESS FRICTION – LIGHTER WEIGHT

FRICTION WITHIN THE ENGINE OFFERS SIGNIFICANT POTENTIAL FOR EMISSIONS REDUCTION. The reason is that frictional losses account for about 25 percent of energy consumption. For example, a crankshaft seal in conventional form generates about one gram of vehicle emissions from frictional resistance. With the development of the gas-lubricated mechanical seal **Levitex**®, Freudenberg Sealing Technologies has managed to cut **frictional losses by 90 percent**. “This brings us very close to our vision of a frictionless engine,” Maschke said. Levitex is just one of many sealing solutions that help reduce frictional losses.

The LESS package offers yet another comprehensive range of solutions to support and optimize downsizing. “With turbocharging, we are undergoing an outright revolution,” Maschke said. “Five years ago, who would have thought that three-cylinder engines in the mid-size segment or four-cylinders in the full-size segment would ever be possible?” Freudenberg Sealing Technologies engineers have developed a number of innovations that keep forced-induction engines at their peak, including low emission values after a long service life. They include **special valve-stem seals with counter-pressure lips, seals made from FKM materials, and POP® seals**. POP seals (POP stands for Power Optimized PTFE) have succeeded at combining greatly reduced friction and greater robustness. The frictional values correspond to those of the Energy Saving Seal. The POP Simmerring can save about 40 watts at 6,000 rpm for a great number of different diameters compared to conventional, first-generation PTFE Simmerrings.



THE FRICTIONLESS REVOLUTION

THE NEW GAS-LUBRICATED MECHANICAL SEAL LEVITEX® NOW HAS EVERY AUTOMAKER TAKING NOTICE, because it operates almost completely friction-free and lowers CO₂ emissions by 0.5 to 1 gram per kilometer. Sören Neuberger is especially gratified by the enormous interest. The young mechanical engineer initiated the development of the new seal at Freudenberg Sealing Technologies.

“Right after the completion of my masters studies parallel with my professional work in 2010, I was allowed to evaluate available technologies for potential further development,” said Neuberger, 28. They included a patent held by Burgmann Automotive, which is owned by the Freudenberg Group. The Bavarian machine manufacturer has produced gas-lubricated mechanical seals for industrial applications since the 1960s, especially for compressors and turbines. Their special feature is the rotating movement between the outer and the inner slide ring, which creates an air cushion that allows the seal to operate practically friction free. “However, the transfer of the concept to high-volume car production remained at the prototype stage,” Neuberger said.

Teaming up with seven colleagues and Karl Woll, Head of Advanced Development, Neuberger developed the idea further. They invented a new, radically simplified concept with four instead of nine separate parts. In 2012, **Levitex** went onto the test stand for the first time and functioned from the outset as hoped. Meanwhile, 19 co-workers have been working on its implementation. The validation of the concept is complete, and all OEM requirements have been met. Neuberger and Woll are confident: “**Levitex** is a new evolutionary stage for crankshaft seals.”

Many a customer considers this assessment to be too modest. For instance, the development chief at a south German vehicle manufacturer says the new seal has revolutionary potential. As one might expect, the customer presentations have been outstanding. “It is normally the exception when suppliers are given a round of applause and development chiefs and managers are personally in attendance, but it is almost the rule for **Levitex**,” Neuberger said, looking forward to the next few years with excitement. The first Levitex seals are running on test stands and in customer prototypes. Series production is planned for 2017.



HIDDEN EFFICIENCIES



THEY ARE SMALL AND INCONSPICUOUS. Sometimes they are even hidden away in an oil pan. But they are achieving great things and are indispensable. Without **hydraulic accumulators**, automated manual transmissions, dual-clutch transmissions and automatic start-stop would hardly be possible. And now a completely innovative generation of **lightweight hydraulic accumulators** is nearing production maturity.

Thorsten Kurz is the Product Marketing Manager at Freudenberg Sealing Technologies' Lead Center Accumulators. When he goes through an auto show, he is surrounded by old "acquaintances" at every stand. But to see them, he has to open up a few hoods. Many major automakers are relying on the technology developed in Remagen. Every year, more than 2.6 million hydraulic accumulators leave the factory in this small town on the Rhine en route to an extremely wide variety of applications.

Hydraulic accumulators make fuel and emissions-reducing technologies possible in the first place. In start-stop systems, they assure that a sufficient oil flow rate is generated within 350 milliseconds during the start process. Transmission shift

elements are supplied with vital pressure or control oil when the engine-driven oil pump stops. With automated manual and dual-clutch transmissions, the membrane or piston accumulator provides the needed pressure.

The new lightweight generation of pressure accumulators is a new, complete development. "We have once again considered the hydraulic accumulator in a completely new way and freed ourselves from all the restrictions," Kurz said. The result – instead of steel painted black, the new accumulator is made from shiny aluminum and, above all, has fewer parts. This was facilitated by a completely new production process, among other factors. In another innovation, joining and filling with nitrogen can now be done in a single step. The weight savings compared to a similar series-production accumulator run as high as 40 percent. "Our new hydraulic accumulators no longer contribute passively to emissions reduction. The lightweight construction concept also allows the hydraulic accumulator itself to actively participate in reducing weight and emissions," said Kurz, a graduate engineer. He won't reveal more than that yet.

Along with the minimization of friction, weight reduction is one of automakers' main development goals for the reduction of fuel consumption and emissions. With the products of Schneegans Freudenberg GmbH, LESS is exploiting the advantages of two or multi-component injection molding as much as possible. It allows the elimination of up to 50 percent of component weight by substituting plastic for metal. This simultaneously results in much greater design freedom and the opportunity to integrate other functions. This aspect has become extremely important, especially as packaging conditions become more difficult.

Freudenberg Sealing Technologies is also putting hydraulic accumulators on a diet. Fabricated from aluminum instead of steel, this efficient, lightweight equipment is opening up new opportunities in dual-clutch transmissions and energy-saving start-stop systems. The LESS package includes additional seal

rings with absolute-value encoders to always give the electronics of an automatic start-stop system the right signal on the crankshaft's position.

ALTERNATIVE POWER-TRAINS AND FUELS

Beyond the internal combustion engine, the LESS performance package includes a variety of solutions that have been tried and tested to production maturity for various alternative technologies. "We are at the beginning of the end of the oil age," Maschke said. "The new age will not be dominated by one powertrain technology and one energy carrier. In the future, we will experience global variety."

For one thing, Freudenberg Sealing Technologies has developed special elastomer seals based on FKM, which withstand aggressive biogenic fuels. For another, LESS offers a broad portfolio of reliable solutions for electric drives. They

involve not only frame seals for pouch cells in lithium-ion batteries and Plug & Seals for the thermal management of state-of-the-art battery systems, "We've also turned to problems that are addressed relatively rarely," Maschke said, citing as an example the conventional Simmerring in electric vehicles. Since the input shaft in these vehicles becomes electrically charged, this can cause damage to the transmission. A specialized Simmerring with an electrically conductive PTFT graphite nonwoven dissipates this tension. It drains the electric charge from the shaft to the housing and effectively eliminates the risk of transmission damage.

Whether a powertrain concept is conventional or alternative – Freudenberg Sealing Technologies offers the auto industry a needs-based solutions kit combining optimal power development, efficiency and extremely high functional safety with resource conservation and climate protection.

SLIMMING DOWN MADE EASY

GREATER PERFORMANCE, SAFETY AND COMFORT HAVE LED TO HEAVIER CARS. The automakers are meeting their CO₂ goals by slimming down with lightweight construction. As it hunts down every superfluous kilo, the company's joint venture with the **Schneegans Group** promises ample results. And they won't only be evident on the scales.

Since October 2012, the newly founded Thermoplastic Sealing Division has supplemented the Freudenberg Sealing Technologies product portfolio with multi-component injection molding parts. Schneegans has proven expertise in injection molding and more than 50 years' experience in the production of high-value plastic and rubber products.

The multi-component injection molding process (thermoplastic with rubber, silicon or TPE) opens up new possibilities to replace relatively heavy metals with lightweight plastic. For example, a **pump housing** made from **2K plastics** for an oil or water circuit is a half kilogram lighter than its metal counterpart. That is not its only advantage, however. It is possible to optimally form flow channels using injection molding assembly technology without expensive processing. The mounting of seals is totally eliminated and installation is much easier than with metal housings, since the injected seals cannot shift. Furthermore, the injection molding

technology opens up much greater opportunities to integrate extra functions or individual parts. Compromises relating to potential system pressures are unnecessary.

2K covers are efficient and beneficial for electrical and electronic assemblies that have an integrated seal between the cover and the housing. This allows automated final assembly – without the manual attachment of the seal. The seals can be individually adapted to their respective companion pieces. Covers with a static seal also help with the absorption and damping of dynamic stresses, improving functional security. And they can provide better fit adjustments even with relatively large temperature fluctuations – which is important for components exposed to intense sunlight and extreme cold. Improvements in acoustics are yet another positive side effect.

Due to downsizing, available installation space is becoming smaller and smaller – for example, in guide tubes for oil dipsticks or "blow-by tubes" for pressure relief on turbochargers. Flexibility is required. **3D all-plastic tubes in free-form** geometries offer the necessary design freedom. They are light and offer great potential for integration. Additional retaining devices or local reinforcements can be combined with a component. This reduces production costs and resource consumption.





SEALING KNOW-HOW

FOR LOW-EMISSION COMMERCIAL VEHICLES

Increasingly strict emissions limits can be achieved with more than just measures inside the engine. Exhaust treatment remains a primary issue. Selective catalytic reduction (SCR) also helps trucks reach the Euro 6 standard. The injection of **AdBlue®** lowers critical nitrogen oxide values in the exhaust by up to 85 percent. At the same time, particulate emissions can be cut by up to 40 percent and fuel consumption by up to 5 percent.

But the liquid urea solution, which is injected into the exhaust gas system with a delivery and dosing module, requires specialist sealing expertise. That's no problem for the materials specialists at Freudenberg Sealing Technologies. Its **AdBlue** portfolio includes elastomers based on EPDM (ethylene propylene diene monomer) and HNBR (hydrogenated acrylonitrile butadiene rubber) with various degrees of hardness for temperature applications down to minus 52° C. In this way, the company can offer the right seal designs for all SCR applications.



BOLSTERING AEROSPACE SALES IN THE U.S.

Freudenberg Sealing Technologies has signed up six more companies as "preferred distributors" so it can serve its discerning American aerospace customers even more effectively and directly. This brings the number of the company's regular U.S. sales partners to 27. The new distributors were recently introduced at a conference in Irvine, California. The company's partner program now includes 60 qualified distributors worldwide. Freudenberg Sealing Technologies' sales partners need to have excellent practical knowledge of the functioning of individual products as well as corresponding industry expertise and experience to handle Freudenberg Sealing Technologies' product and service portfolio, which is sophisticated from both a technology and a quality standpoint. The **"Preferred Distributor"** program of the Weinheim-based sealing specialist offers its partners the right framework to support their shared customers across the board with a wide range of training resources, global support programs and services.

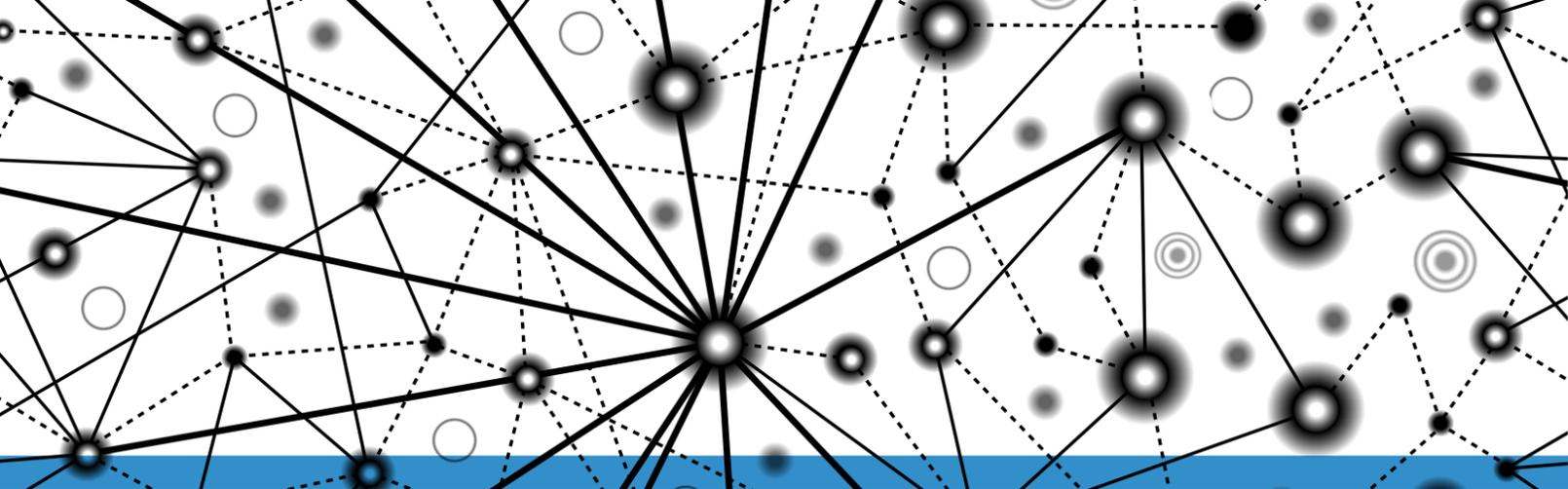


A SEAL FOR A LIFELINE



For nearly 100 years, it has connected the Atlantic and the Pacific, and remains one of the most important lifelines of world trade. The 82-kilometer Panama Canal shortens a ship's passage from the West Coast to the East Coast of the United States by about three weeks. Work on its expansion has been underway since 2007. Its core is a new, three-stage lock system with chambers up to 427 meters long, allowing passage of larger ocean-going giants.

The existing locks are being modernized as part of the expansion. In January 2013, a gear manufacturer needed 130 large Simmerrings with a diameter of more than 300 millimeters on short notice for the canal's huge lock gates. Measurements of this size require special fabrication. Just five days later, the first load of 70 "maxi" Simmerrings left the production facility. As agreed, the second load followed in March. Since then, the lock gates have been opening and closing more quickly than their predecessors – which substantially shortens the layover for approximately 14,000 ships per year.



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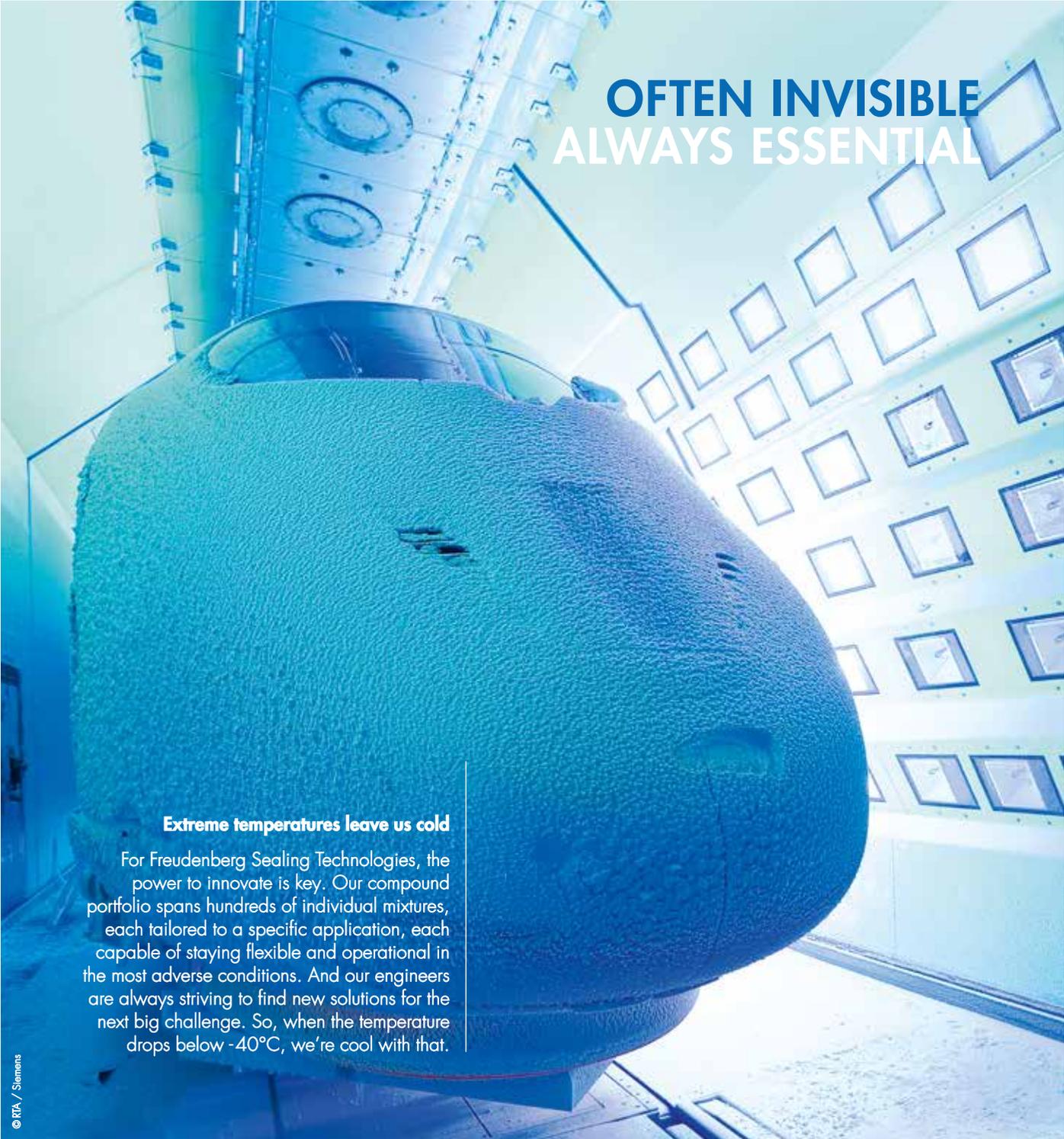
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Climate neutrally produced



**OFTEN INVISIBLE
ALWAYS ESSENTIAL**

Extreme temperatures leave us cold

For Freudenberg Sealing Technologies, the power to innovate is key. Our compound portfolio spans hundreds of individual mixtures, each tailored to a specific application, each capable of staying flexible and operational in the most adverse conditions. And our engineers are always striving to find new solutions for the next big challenge. So, when the temperature drops below -40°C, we're cool with that.

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