



ESSENTIAL

FREUDENBERG SEALING TECHNOLOGIES
THE MAGAZINE – ISSUE #2 2018

A graphic of a water splash with a single drop falling into a pool of water, creating ripples and bubbles. The splash is positioned behind the letter 'H' of the word 'THIRSTY'.

THIRSTY

THIRST FOR MORE

What drives us to stay curious and keep growing.

EXTREME SWIMMER

A conversation with André Wiersig on ice-cold water, sharks, epic goals and willpower.

THE FULL FLAVOR

The wide range of beverages is placing greater demands on producers and their equipment.

CAN YOU DRINK THAT?

How thirst-quenchers could come from saltwater and icebergs.



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THIRST FOR MORE

By Claus Möhlenkamp, Chief Executive Officer of
Freudenberg Sealing Technologies

Thirst is natural. It is how the body seeks to balance its fluid equilibrium. Each one of us knows what it means to be thirsty. Although we can quench our thirst for a time, it will always return. It is insatiable.

In all likelihood, this very phenomenon led a wordsmith to coin the phrase “Thirst for Knowledge.” It is a phrase that, interestingly enough, is found in other languages, including German and French. Curiosity – the state of being thirsty for knowledge – is basically an insatiable need. It has been driving humanity since its beginnings. Even the history of Freudenberg is shaped by a thirst for knowledge. This can be seen in its development from a tannery to a seal manufacturer and beyond. Freudenberg is thirsty for knowledge. We are curious about the future. We are not just engaged with the present – we consider where key trends and technologies are going.

For example, we invested in research on fuel cells and their development as powertrains early and systematically, back when the technology seemed to offer little promise. In many cases, Freudenberg Sealing Technologies has developed its own ideas to meet the special requirements of batteries, to prevent declines in performance or provide thermal management systems. All these ideas have something in common: they were all developed proactively. Products are already in our portfolio before the overall commercial technologies’ ultimate



THIRST IS OUR MOTIVATION.
IT MOVES US.
IT GETS US GOING.

breakthroughs. Along with a business motive, the thirst for knowledge is always a key factor early in their development. Whether the idea involves materials, components or product development, we put our faith in systematic innovation management, in close coordination with our customers, so we can meet their needs. You could put it this way: to quench their thirst.

Thirst is our motivation. It moves us. It gets us going. If you're not thirsty, you are sated – satisfied – for a time. But a continual state of satisfaction doesn't get you anywhere. Satisfaction is not a positive in science, sports or business. If you are satisfied, you are sluggish. Most failures occur shortly after a success. You will certainly have no trouble recalling examples of athletes resting on their laurels after a victory. Or successful companies that neglected their development. Their rivals passed them by. Three times in a row, a reigning soccer champion was eliminated in the preliminaries at the next World Cup. Many a brand name that was once the "top dog" in an industry has lapsed into insignificance.

Of course, thirst has its downside – namely when it cannot be satisfied. So far, we have mainly considered thirst from a philosophical standpoint – but we are not forgetting that true, physical thirst can be horrendous. But even here it has a symbolic character: if the global population continues to grow, the issue of resources will emerge. With a rising population, how can we ensure that every human being has access to drinking water, food, education and work? How do we meet the challenges of mobility and urbanization? Freudenberg Sealing Technologies is dealing with these issues in a number of different ways.

One thing is clear: the future has changes in store for us. We will be forced to embrace new ways of generating and using energy as raw materials become less available and the global population grows. Megacities have to find new approaches to mobility – electric mobility is expected to play a major role here. In agriculture, the trend toward larger vehicles has been underway for a while, putting new demands on components.

Among other things, all these megatrends will place a premium on efficiency – a topic that we, as a sealing specialist, understand very well. Our products have always been measured in at least two important ways: how well they perform their basic task and how well they minimize frictional resistance. "The thirst for more" isn't necessarily a reference to quantity. It can be a call for quality: greater efficiency, greater sustainability, and greater future opportunities for all of us.

"The thirst for more" motivates people whenever they are in competition with one another. As we saw above, sports is one example. We encounter it in athletes in a variety of forms. If you exert yourself physically, you get thirsty. Drinking too much or drinking improperly may slow your stride. If you want to continue to be successful, in a figurative sense, you have to stay thirsty.

So I am serious when I say we should all stay thirsty. In the sense of our motivation. Let's be thirsty for knowledge and curious about the future and what it holds for us. Let's all commit ourselves to sustainable growth and innovative ideas that provide solutions for tomorrow's world. That is what we do at Freudenberg.

IF YOU WANT TO CONTINUE
TO BE SUCCESSFUL, YOU HAVE
TO STAY THIRSTY.



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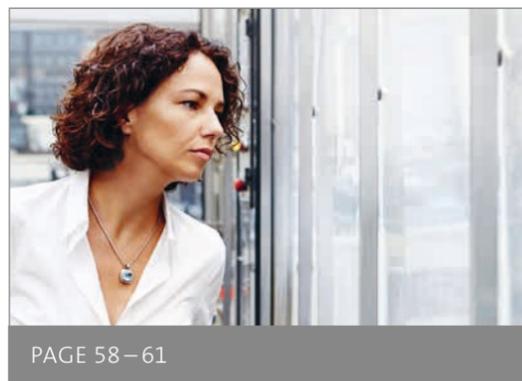
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IMPRESSIVE CONDUITS

In the history of humanity, the availability of water has been indispensable for the development and continuity of advanced cultures. In South America, the Incas built large-scale terraces for agriculture and irrigated them with canals. Similar waterways supplied their capital Cusco at an elevation of 3,400 meters. In ancient Egypt and China, elaborate canal systems were used to steer water into the desired paths to support farming. The Romans relied on aqueducts to direct water to their cities. Even today, their remains – visible here in Tarragona, Spain – testify to impressive engineering feats whose sole purpose was to satisfy humanity's thirst.





VALUABLE DROPLETS

Water is considered to be the elixir of life – and global population growth is turning it into a very expensive commodity. Most water is used in agriculture, but conventional surface irrigation is not an efficient way to give plants the moisture they need. Drip irrigation, which has its origins in Israel, is much more targeted. The system relies on perforated hoses that deliver the water to the plants, which are expected to use 90 percent of it. The plants' thirst can be satisfied even more efficiently if sensors are placed in the soil. The hose system can be used to apply and control the amount of pesticides and fertilizers that are employed. The result is reduced water consumption and higher yields.



THIRST FOR KNOWLEDGE

There is little that drives human beings the way curiosity does. Every day researchers devote themselves to the unsolved riddles of science, and their thirst for knowledge brings groundbreaking insights to light, which are presented in publications and hence serve as a fountain of inspiration for other researchers. The United States stands out in this respect. The Nobel Prize committee lists nine institutes and universities from the U.S. among the ten most-awarded institutions in the categories of physics, chemistry, medicine and economics. The great freedom that academic researchers enjoy is considered crucial to their scientific success and the award of their many Nobel honors. As is the solid financial foundation of the institutions and their attraction to top and junior researchers from all over the world.



Reason to smile: Extreme swimmer André Wiersig doesn't mind wind, waves or weather. For him, the sea is more than just a pretty backdrop.



“JUST GET OUT OF YOUR COMFORT ZONE”

André Wiersig has set a goal: he wants to be the tenth person ever to swim the “Ocean’s Seven,” seven straits and channels around the world that are between 10 and 40 kilometers (6 to 25 miles) wide. Every year, he takes on a new one. He has just returned from one of his crossings in Japan, and he still has two left to do. A conversation about drive, self-determination and the different kinds of thirst, and what you can learn from the struggle against high waves, currents and sharks and apply to your professional life.

HOW DO YOU LOOK AT THIRST, MR. WIERSIG?

First, and foremost, it is a stimulus, a reminder to take care of certain things. There are needs that have to be met. But this immediately poses the question: would I like to eat something or am I really hungry? How strong is the stimulus, and how strong do I perceive it? I have swum through very cold water and I thought that I was cold. Today I don't even consider similar temperatures to be cold. My sense of thirst is certainly no longer the same as it was eight years ago. I have moved to another level.

IN OTHER WORDS, THIRST, COLD AND HUNGER ARE RELATIVE?

Our ancestors probably knew real thirst. What we experience today is at most a hint of that feeling. Once, during the running portion of an Ironman competition, I was on the lookout for cows on because I was ready to drink out of their trough out

of sheer thirst. We have everything in our lives. There's always hot water and food. Not only that – it is precisely the food that I like the most. Everything is there. Even information is endlessly available. Today we are living in our comfort zone. The question is: what do we make of our lives?

YOU DELIBERATELY LEAVE THIS COMFORT ZONE TO TRAVEL AROUND THE WORLD AND SWIM ACROSS STRAITS AND CHANNELS THAT ARE THIRTY OR FORTY KILOMETERS WIDE.

Look, the sea is becoming a mere backdrop today. When people travel to the ocean, they swim in the hotel pool, not offshore. On your next vacation, head over to the beach and go into the water, and then swim straight out into the darkness. That's how I start my crossings. I expose myself to nature. If you are out between the Hawaiian Islands, the water is extremely deep, the waves are high, and there are sharks, whales and poisonous jellyfish.



„I am driven by the contrast to everyday life.“ Wiersig crossing the Tsugaru Strait.

You are completely in the hands of nature. I did have a boat accompanying me, but it couldn't help me in an emergency. It couldn't come too close due to the high waves. Otherwise, it would run me over.

YOU HAVEN'T EVEN MENTIONED THE COLD.

In the English Channel, the water temperature was around 13°C (55°F). Untrained people in bathing suits only survive that temperature for about an hour. In some cases, I was swimming for twelve hours at a stretch. It works – the body withstands it. But you have to prepare for it. I only took cold showers for three years – with no exceptions – with ice cold water from a rain barrel. That was an insane accomplishment, but any of us can basically do that.

WHAT DRIVES SOMEONE LIKE YOU TO SUFFER THESE TRIBULATIONS?

The contrast to everyday life. I do have a job. I take the S-Bahn to the office. There are people everywhere. You can reach them at any time. On the other hand, everything outdoors has a pure character. A self-determining character. You feel nature, but you can't compel nature to do anything. You can't fight the waves. No matter how well I prepare myself, if the ocean doesn't cooperate, I can't swim against it. I love that part.

YOU LOVE IT? WHY?

You completely become part of the ocean. You are a tiny speck being driven around. It is fantastic. You have to give yourself over to it.

AND YOU HAVE TO GIVE YOURSELF OVER TO SHARKS?

The sharks are there. It would be fatal and crazy for me to try and fool myself and say, "It will be fine. There aren't any sharks here." On the other hand, I can't allow myself to be frightened if I run into one. I am a guest. This is his home. I am the intruder. I've already been stung by a Portuguese man of war, and I would not wish that pain on my worst enemy. It lasts an hour, then it slowly subsides.

IN THESE SITUATIONS, DON'T YOU EVER THINK ABOUT GIVING UP?

You naturally think about giving up. That's not really a bad thing. I don't believe the people who say, "I'll never give up!" You can question the situation, but, in the meantime, you carry on. And suddenly the thought of giving up becomes weaker and weaker. I've often decided to stop in a half-hour, and suddenly you are swimming another half hour, and then yet another. Then the sun comes out and you have banished the thought because it's all already six or seven hours old and the coast is not far off. Dark feelings can consume you.

IF YOU'RE STUNG BY A JELLYFISH, NO ONE WOULD BLAME YOU FOR GIVING UP.

Sure, when the pain has practically robbed you of your senses. That's when I consider whether I will break it off. But then I figure I'll have the pain anyway even if I am just sitting in the boat. I might as well start swimming again. The body functions. Each of us is intended for entirely different things.

At the training camp on Majorca, I sometimes swim into jellyfish deliberately. You learn to deal with the pain. That is also a triumph. It keeps you from panicking. I believe Portuguese men of war are only deadly when people panic and drown.

THE MOST IMPORTANT RULE IN ANY LIFE SITUATION IS TO STAY CALM?

Yes. The same thing applies when you encounter sharks. The shark knows the situation. Everything flips out when it shows up. It is used to that. This arouses his hunter instinct. If I stay calm, it ignores me.

THAT FRANKLY SOUNDS AS THOUGH IT IS EASIER SAID THAN DONE

You can't put on an act with a shark. Either you are calm or you are not. That's another lesson for everyday life. Today we all want to look cool, and technology gives us a way to do that. We are used to retouching our photos to improve them, so we can look better than we do in real life. But you can't fool an animal. The shark senses this. I really see parallels in our working lives. We often run into extreme

“YOU CAN'T PUT ON AN ACT WITH A SHARK.”

circumstances at work. There are so many things raining down on us, multiple, simultaneous challenges, that you cannot influence or can only influence in a limited way. The same thing applies in these cases: don't panic. Raise questions – yes. But keep the goal in view.

IF SOMEONE IS THIRSTY FOR ACCOMPLISHMENT, MEANING THAT HE WANTS TO ACHIEVE SOMETHING, DOES HE NEED TO HAVE A CONCRETE OBJECTIVE?

There are company goals in everyday life. These goals are prescribed for us. But there is a difference if I set the goal myself. People who make deliberate plans have a different posture. They have an impact on their entire environment. You feel the self-confidence. That is no different from what I do. Standing on the beach at night and then plunging into the water – that takes self-confidence.

DO YOU SEE LESSONS FOR EVERYDAY BUSINESS LIFE?

Certainly. I cannot directly influence the ocean and the wind. I can only have an impact on myself and my own attitude. It is exactly the same at work and in your personal life. The dissatisfaction that many people feel often stems from the fact that they



PORTUGUESE MAN OF WAR

This impressive marine animal with its extended, bluish "bell" and tentacles up to 50 meters in length can kill smaller fish with its poison. For humans, contact is extremely painful and leaves behind welts resembling whipping scars. The encounters occasionally end in death. The animal mainly lives in the Pacific Ocean, the Caribbean and the Canary Islands.

personally feel responsible for so little. I tell people to stop playing the victim. If the waves are high, it doesn't do any good to yell and scream that the ocean is to blame. There are factors that I cannot affect, and I have to be aware of the situation ahead of time.

IN BUSINESS, REACHING GOALS OFTEN REQUIRES TEAMWORK. DO YOU HAVE A TEAM?

Yes, though it is a small one. But every member of the team does what he does best. Everyone contributes based on his strengths. My brother-in-law, for example, is a very key person, namely the man in the boat. He is absolutely reliable and is never seasick. I know the degree to which I can rely on him. That is extremely important. I have to know exactly what every member of my team can do. But in the end, I swim alone. That is my role. I am responsible for that.

HOW DO YOU DEAL WITH SETBACKS?

By accepting them. In Japan, the coast was within reach, but it took me six hours to cover the last four kilometers (2.5 miles) due to the current. Mind you, I was swimming at four kilometers per hour during this period, as I was on the previous stretch. You are swimming all out, but you aren't making progress, and you have already been in the water for seven



ANDRÉ WIERSIG

A native of Paderborn, Wiersig competed in triathlons at a near-professional level during the 1990s and began participating again in 2002 after a break, parallel with a full-time job in IT and his family life. The idea to swim across seven ocean passages emerged from his experiences. Wiersig has also been lecturing at companies on goal attainment and personal character and is involved with environmental projects. He is currently looking for sponsors for the final two sea crossings.

hours. In the end, it took me thirteen hours. There were others ahead of me that had more luck with the current and weather, and made it in seven hours. That's just how it is.

HOW DO OTHER PEOPLE REACT WHEN YOU TELL THEM THAT YOU SWIM ACROSS STRAITS AND CHANNELS IN YOUR FREE TIME?

Many are fascinated, but many can't comprehend it. We human beings have a tendency to project things on ourselves. If I believe that I can't do something myself, then I call it "crazy." That's a shame. Admittedly, when I travel to England on the ferry and look down into the water, I ask myself: You swam across this? How did you do that?

LET'S TAKE A LOOK AT THIRST IN A CONCRETE SENSE: YOU ARE SURROUNDED BY SALT WATER, BUT YOU CAN'T DRINK IT. HOW ARE YOU SUPPLIED?

I drink something every half hour. It includes nutrition. You can't swim and chew at the same time. But I'm not allowed to touch the boat. My liquid nutrition is handed to me. You can't let yourself drift due to the current, so you have to keep swimming. I adhere strictly to this rhythm. I don't really have a choice since the boat has often moved away. Incidentally, you can't take in all calories that you need. I have already experimented a great deal with this: a swim over these distances consumes more than 18,000 kilocalories. At the end, you are just tired. There is no feeling of exhilaration – the kind that marathoners feel at the finish line. You are really alone. You are relieved and happy, but on a different level. The feeling continues for months. It always lasts a long time.

DOESN'T OFFICE WORK SEEM HORRIBLY BANAL AFTERWARDS?

No, I feel even better and more efficient. Refreshed. Perhaps like a computer that was shut down and then booted up again. It does you good to get back to normal. The two aspects around each other out. I don't merely want to be part of the oceanic world. You don't have any diversions when you are swimming. When I'm running or riding a bicycle, I see forests and the rest of nature. But you don't see anything when you are swimming. Unless it is a shark that shows up a half-meter (1.6 feet) in front of you.

WE KEEP HEARING THAT OUR OCEANS ARE FILLING UP WITH TRASH. DO YOU ENCOUNTER SOME OF IT WHILE YOU ARE SWIMMING?

I once swam into a plastic tarp at night in the English Channel. That will give you the shock of your life. You don't know what it is. If you are swimming around in your bathing suit, you are fully exposed to all of it. But you don't really get the large garbage patches that you see in the media – and I run into micro plastics to a limited degree. There is much more lying beneath the surface. I have had the feeling for some time that I need to talk about all of it. I have to tell people how things really are. I am even trying to encourage children to swim in the ocean. It is really important for us to see the natural world around us.

WHAT HAS TO CHANGE?

The awareness. We have to be aware that this garbage comes from us and we have to take responsibility for what we have done. Not some president, not some government. All of us. We have to get away from thinking small or even in terms of nations. The sea knows no boundaries.

A MAJOR TASK.

A huge task! But people can start taking action themselves. Whether I'm on the beach gathering trash or if I buy an electric car. Above all, it is a matter of sending a signal, getting started and doing it. We have to change our thinking and our actions.

AS YOU SAID EARLIER, SETTING GOALS FOR OURSELVES?

Yes. We are back at the beginning. I need self-confidence to set goals. If you succeed at doing what you personally have resolved to do, you have achieved a tremendous success. The first step is self-confidence. I can do what I have resolved to do. And then I prove it to myself. Many of us resolve to do something but never test ourselves.

BUT IT DOESN'T HAVE TO BE AN OCEANIC CROSSING, DOES IT?

Oh no. I more often talk about trying out something new and getting out of your comfort zone – on your own. And not because your partner tells you to become more active physically.

WHEN DO THE PREPARATIONS BEGIN FOR YOUR NEXT CROSSING?

They are already underway. I am going to be swimming off New Zealand during the Easter holidays in 2019. These waters are considered the stormiest strait in the world. There are huge waves and often a great many sharks, and box jellyfish. I would prefer not to be in the water longer than necessary.

DO YOU ACTUALLY HAVE TIME TO SEE THESE COUNTRIES WHILE YOU ARE THERE?

You run into people off the beaten tourist paths. In Japan, I met fishermen who have lived in the area for generations. These people have an in-depth

understanding of the local waters. The passage off the coast of Hawaii is, for example, the traditional route for a local canoe race. There have been people who went adrift and never came back. When these people see you're going to swim across the passage, they have a reverential respect for you. I admit it gives me goosebumps. ©



OCEAN'S SEVEN

Only ten people in the world have met the challenge of swimming across seven ocean straits or channels, including the English Channel, the Cook Strait and the Tsugaru Channel between the Japanese islands of Honshu in Hokkaido. The routes are spread across the world, but do not involve every continent. Ocean's Seven was devised as an equivalent to the "Seven Summits," a challenge for mountain climbers encompassing the world's highest mountains.



CAN YOU DRINK THAT?

Our planet has an abundance of water. But most of it is unfit or difficult to drink. It can be found in chunks of ice or in the form of salt water, dirty brackish water or wastewater. None of these are suitable for consumption. Or are they? Maybe it will just take a little ingenuity if we want to quench our thirst.

DRINKING WATER FROM ICEBERGS

It sounds like a scene from a comic book: towing an iceberg by ship to the coast and then melting it into drinking water. In fact, the idea is theoretically feasible. Around the world, companies and individuals have independently developed methods to transport icebergs from the Antarctic to South Africa or from the Arctic to the Canary Islands. Two-thirds of the world's freshwater is bound up in polar ice. A single 7-million-ton iceberg could cover the annual water needs of 40,000 to 70,000 people, even if it melts down to 4 million tons during the voyage.

Most of the models rely on ocean currents so the iceberg only needs to be "steered," not towed. Instead of fighting the waves, the approach calls for controlled drifting – in the Antarctic circumpolar current, for example. The technology has even been tested: ships can protect oil drilling platforms from collisions with icebergs; they simply steer them in another direction. Another issue is more complicated: how is the pure water from the iceberg kept from becoming contaminated with salt water, oil or emissions from the tugboat? But solutions have even been proposed for those problems. It would be conceivable to wrap the iceberg in plastic before the voyage begins.

The water from the iceberg can be tapped on-site. The fact that icebergs melt in a warm environment would not be a problem – this would be built into the planning. But questions remain: it is impossible to see how well techniques such as wrapping and steering would work in the harsh conditions of the notoriously stormy South Polar Sea. And finally, the tons of cold freshwater would likely have unanticipated consequences for the ecosystem at the destination. It would take investors to bring idea through its testing phase successfully. Various companies put the cost between \$12 million and \$70 million. For the time being, that means getting drinking water from icebergs wouldn't make sense. The cost and the sheer amount of energy consumed would be too high.

Still, the undertaking would not necessarily overexploit the planet's resources. After all, icebergs break away from the landmass of the Antarctic and drift north every year, where they melt into the ocean. The freshwater resulting from this approach could cover a large share of humanity's water needs, and new ice would form during the winter months. And there is a potential alternative to the challenge of towing icebergs. Large tankers could travel into the Antarctic and gather ice there. But the costs of this solution are unclear as well.





ALL PSYCHOLOGY

Wastewater can already be purified to drinking quality today. But very few people want to drink it.

DRINKING WATER FROM WASTEWATER

From the toilet into the faucet? The very idea likely gives most people a queasy feeling. In fact, the main reason that this approach to water usage has not caught on around the world is purely psychological. Recycled wastewater is a tough sell.

The process involves cleansing the water of microbes and then using reverse osmosis to rid the liquid of the smallest possible particles. Although that would be sufficient in theory, there is an additional step, usually ultraviolet light to provide complete sterilization. At that point, the water can go back to households. But that usually doesn't happen for psychological reasons. Instead the purified water is guided into reservoirs such as lakes or aquifers and then drawn off after a few months. It then goes through a complete cleansing process again. That's because people are more comfortable with drinking water "from nature" than directly from a sewage treatment plant.

Pure freshwater is a myth anyway. When cities draw their drinking water from a river, there is almost always another city upstream that releases its (hopefully purified) wastewater into it. Groundwater reservoirs and

lakes may also be contaminated, and, quite generally, no water reaches our households nowadays that hasn't been elaborately filtered in advance. Cities and communities worldwide are already experimenting with wastewater recycling. There are now facilities for it in California and Australia, and Namibia's capital Windhoek is considered a pioneer. Even Israel is recycling 80 percent of its wastewater, but largely for use in agriculture.

Singapore is the country with the widest-ranging experience. Although its rainfall is double the global average and half of its surface area is dedicated to filling reservoirs, the densely populated city state cannot cover its water usage – not on its own, using its own resources. Singapore has done research on wastewater recycling since 1974, and the breakthrough came in the 2000s. Today four facilities treat wastewater with microfiltration, reverse osmosis and ultraviolet radiation to a level of purity exceeding the country's traditional drinking water. The result is so pure, clear and germ-free that the water isn't routed back to the faucet – it goes to industries that need extremely pure water for their processes.

DRINKING WATER FROM SALT WATER

They are already tightly packed on the coasts of the Middle East, the United States and the Mediterranean Sea. There are 16,000 sea water desalination facilities installed worldwide, and an end to the boom is not in sight. Saudi Arabia already gets 70 percent of its drinking water from sea water, and the United Arab Emirates has the world's largest desalination plant in Dubai: 2 billion liters of sea water are converted into drinking water every day, a quantity that would fill 80 Olympic swimming pools. Obtaining drinking water from salt water has long been a reality.

Two technologies are currently in use: either the water is pressed through semi-permeable membranes with the help of reverse osmosis, filtering out the salt – or the water is heated and vaporized, and then the condensate – now free of salt – is captured. The problem with the two technologies is energy consumption. Reverse osmosis consumes about 3 kWh of electricity for each 1,000 liters of water, and the process known as flash evaporation requires 10 kWh. Sea water desalination is currently a very costly and energy-intensive way to produce drinking water,

Since many countries in the Middle East have large energy reserves, the desalinated water is heavily subsidized. The official prices of water in Saudi Arabia and Qatar are among the cheapest in the world. So there is no incentive for conservation. Paradoxically,

many countries are fueling climate change with their reliance on fossil energy, which leads to water shortages. In turn, the strategy makes sea water desalination even more necessary.

But research is underway in this area as well. Since reverse osmosis relies exclusively on electricity, not heat, an application using renewable energy would be conceivable. Photovoltaic systems are one possibility. Scientists and engineers are also tinkering with new methods like electro-dialysis and electro-deionization, which remove salt ions from the water through the use of membranes. Due to the laws of physics, it does not appear possible to come in under the minimum conceivable figure of 1.5 kWh. In 2008, Singapore organized a contest with several million dollars in prize money, to see how close the competitors could get to this value. The bottom line was that it takes some form of energy to extract salt from sea water.

There is another ecological problem: the salt lakes resulting from the process must be reintroduced to the ocean extremely carefully. A continuing rapid increase in desalination could turn them into waste-disposal problems. There is a political risk as well. Geo-strategists point out that countries become vulnerable when they get all their drinking water from desalination plants – which could be easy targets during conflicts. ©

INFINITE RESOURCE
There is an abundance of salt water, but very much energy is needed to produce drinking water from it.





NEW ON THE MENU

The range of beverages and foods has expanded enormously over the last few decades. The arrival of new products in supermarkets and restaurants often reflects the zeitgeist of the era. We tracked down the stories of several of them.

CRAFT BEER

Origin

The United States. Craft beers first made their appearance in the U.S. during the late 1970s. But they took twenty years to catch on. And now Europeans are brewing and enjoying them.

Background

It is impossible to talk about craft beer per se. The term is interpreted differently from one country to another. It is ultimately a question of rediscovering beer away from the major, well-known brands and in relatively small breweries that brew new creations with natural ingredients and great dedication. Craft beers are characterized by their great diversity of tastes and varieties.

Recipe for success

Even if beer purists don't like to hear it, the popularity of craft beers is founded on their hearty taste, which comes from the aromatic hops that these brewers like to use in abundance. This can lead to beers with fruity or chocolatey tastes. Some brewers even add fruit, herbs or spices to their beers. Craft beer has a market share of about 13 percent in the U.S. In Germany, the figure is thought to be 1 percent, although the trend is noticeably on the rise. ©



QUINOA

Origin

The Andes. For thousands of years, quinoa has been considered a cultivated plant and an important source of nutrition. Over the last ten years, the seeds have been making their triumphant march around the world.

Background

Quinoa, which resembles rice, has developed the image of a healthy and wholesome grain substitute. Long before all the current hype, NASA was working with the very filling quinoa seeds in the 1990s, considering it to be a food for astronauts.

Recipe for success

Quinoa is enriching cuisines in a growing number of countries. It is a welcome alternative for anyone unable to tolerate gluten, since it has none. Quinoa also supplies all nine essential amino acids, which makes it an appealing meat substitute. It is no surprise that McDonald's veggie burgers in Germany are based in part on quinoa. The demand is generating more production of the crop worldwide; output rose fourfold over the last decade. But there's a downside to the success. Many farmers in the Andes are facing competition from new acreage. They are selling less even as consumer prices in the domestic market remain high. ©



SMOOTHIE

Origin

The United States. Around 1930, smoothies began to enrich the already established juice bar culture in this country. During the last decade, smoothies washed onto the shores of the European mainland from the United Kingdom.

Background

The first smoothies were made from pureed fruit, fruit juice, a little ice, vanilla extract and sugar. The drinks were thick and not as acidic as fruit juice. They were considered to be healthy and wholesome. They were easy to make, even at home. It wasn't long before food companies were producing them.

Recipe for success

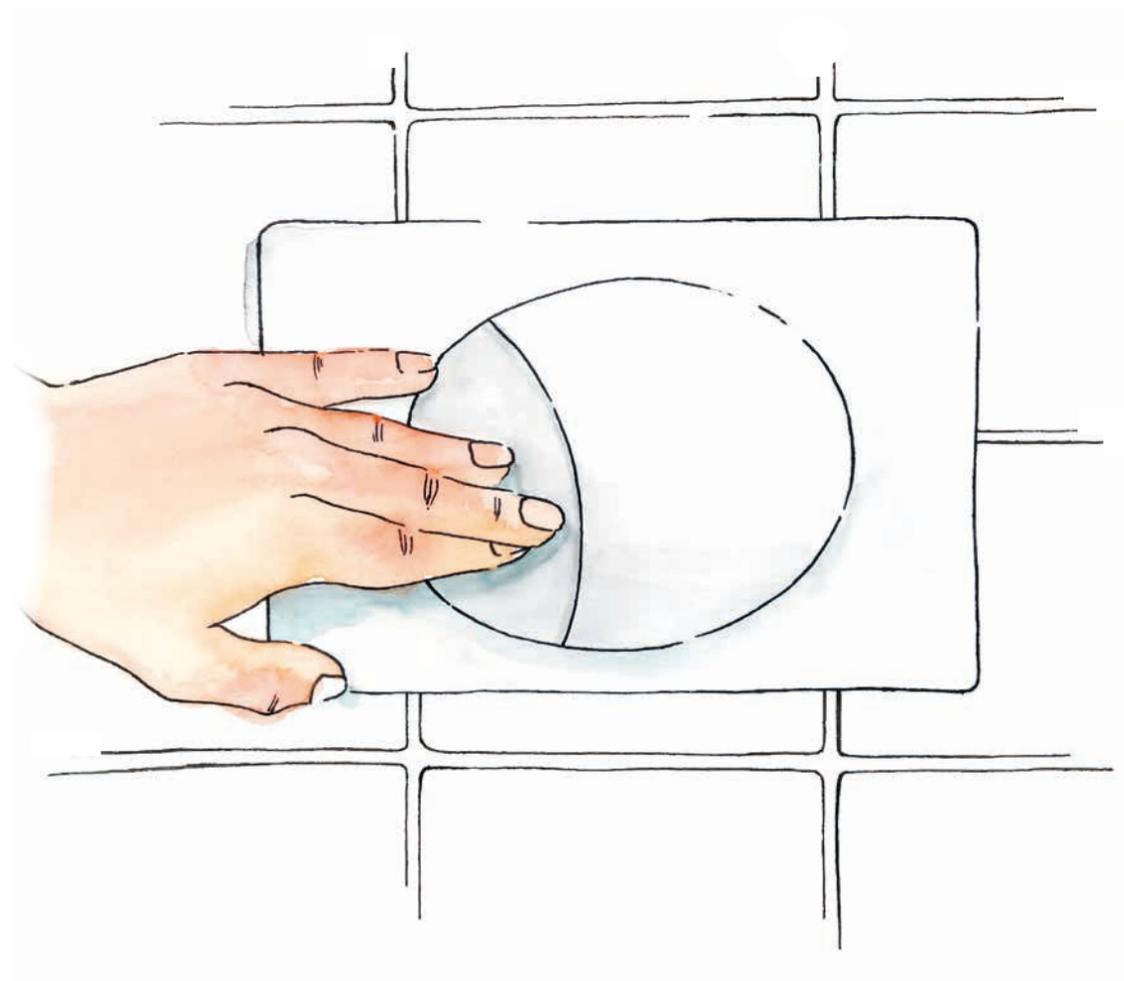
Today it is hard to find a supermarket that doesn't carry smoothies. Their producers are happy to point out the high share of fruit in the recipes. Smoothies owe their success to the fact that they can be consumed more quickly than fruit. But when their makers resort to fruit concentrates and synthetic ingredients, they contradict the basic idea of smoothies. Meanwhile, there is no end to the hype – and no limits on the variety of ingredients that can be used. Green smoothies made of vegetables are now rounding out product lines. Analysts are forecasting global growth of more than 8 percent in the smoothie market between 2017 and 2021. ©





WE COULD SAVE OURSELVES SOME TROUBLE

Conserving water has become a popular activity in German homes. But it is creating problems elsewhere and raising some questions: how, why and when should we save water?



Foreign visitors sometimes conclude Germans are a strange bunch after visiting a bathroom in one of their homes. The standard equipment on their toilets includes a large and a small button to flush with more or less water – features largely unknown in the rest of the world. In 2014, the “Wall Street Journal” took the time to regale its astonished readers about Germany’s creative approach to water conservation. The story was retold, quoted and discussed in other newspapers and blogs. Even as early as primary school, German children are already taught not to run the water the whole time they are brushing their teeth.

Germans are even spending money on water conservation: almost across the board over the past few decades, they have regularly exchanged their old wash machines and dishwashers for new low-consumption appliances. The effect: on average, a German uses just 120 liters of water per day at home. The number is nearly 300 liters in the United States and Japan. That certainly doesn’t make Germans the world champions of water conservation, but they are making a huge effort to cut back on its use. And that turns out to be a problem.

WATER LINES TOO LARGE FOR TOO LITTLE WATER

The water lines in Germany are just too large. In some regions, drinking water flows too slowly through the pipes, allowing microbes to grow. The problem is the same in the other direction: wastewater no longer flushes all the deposits out of sewer systems reliably. The pipes not only stink – they can even be damaged by the putrefaction. The curious result is that Germans are now conserving too much water; in some cases, the lines must deliberately be flooded with drinking water. “In the German consciousness, water conservation is a civic responsibility,” the weekly newspaper “Die Zeit” wrote pointedly several years ago. It called for a rethinking of Germany’s water conservation ethic. What is the point of turning off faucets while you are brushing your teeth if it doesn’t accomplish anything? It said many people had a misconception about the water cycle: the idea that all is well if a country uses no more water than the amount of precipitation that becomes groundwater. “Forget water conservation,” the newspaper admonished its readers in the article’s headline.

During the 1970s, German engineers and city planners assumed that water use would simply continue to rise and planned for double the amount actually used today. But people are not only more economical in their water use at home – in industrial environments, they use less of the resource than planners could have imagined forty years ago. On average, water is used nearly six times thanks to water circuits. Water conservation has not led to falling water prices since much of a water plant's costs are fixed – including loan repayments and outlays for infrastructure and staffing. Paradoxically, low levels of water use can even encourage water plants to raise their rates to improve their finances.

ONWARD, WATER?

“It still makes sense to deal with water carefully,” said Corinna Baumgarten of the German Environmental Agency. “Water does have value.” Especially in the case of hot water, the issue is not just usage – it is the energy consumed to heat it as well. Generally speaking, it would be absurd to waste water just because a few lines are too large, said Baumgarten, who is an engineer. “Communities and water suppliers regularly clean out the lines or flush water through them on a controlled basis,” she said. She argues that every consumer should have a better understanding of the actual source of his water. Does his community draw it over long distances from a remote lake or does it have high-quality groundwater? “The more expensive the acquisition and processing of the water, the more important it is to deal with it sustainably,” she said. The time of year is a factor as well: during the summer, prudent conservation efforts are even more important.

Unfortunately, it is impossible for a country with surplus water to supply other regions. From an energy standpoint, it would make little sense to haul

German water to dry regions of Spain in tankers. “The question should rather be to what extent are we Germans, as water consumers, contributing to consumption in Spain,” Baumgarten said.

“WE HAVE OUTSOURCED WATER CONSUMPTION”

The use of water in an individual's household is just part of what people actually use. “In Germany, we have successfully outsourced the largest portion of our water consumption abroad,” wrote Nikolas Geiler, a limnologist in a paper on water conservation. The food and raw materials that Germans import also consume water – only the consumption is in another country. “Our imports represent a higher amount of water use than the entire amount of precipitation that falls on Germany,” Geiler said.



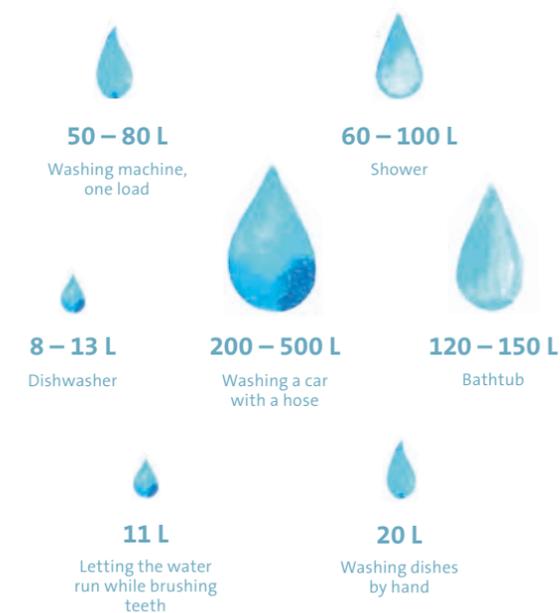
Geiler described this idea a decade ago, and the concept of a “virtual water footprint” has taken root. Despite his exemplary 120 liters of water use per day, the footprint of the average German actually rises to 4,000 liters of water per day by this calculation. If you buy tomatoes from Southern Spain or wear T-shirts made of cotton from Egypt, you are promoting water consumption in countries with little precipitation – that is, countries that presumably need to process their drinking water with elaborate measures. According to some estimates, just one T-shirt requires the consumption of about 3,000 liters of so-called virtual water to irrigate plants and clean the dyeing facilities. Meats also score high: experts put the water use for a single steak at 7,000 liters.

HIGH- OR LOW- PRECIPITATION REGIONS

So should there be a labeling requirement for virtual water? “Consumers already see so many product labels that one more water-related label would surpass the limits of their comprehension,” said Baumgarten of the German Environment Agency. There is another issue: what does the amount of water used to make the products mean? There is a difference between a cotton shirt that can be traced back to the over-exploitation of water in an arid country like Uzbekistan and the coffee or tea from a country with more precipitation than Germany. But none of these considerations are much help. A simple label can't give us the license to ignore a guilty conscience – which can't solve these problems anyway. That's clear from the partly paradoxical results achieved by would-be champions of water conservation in Germany. Instead, people need a better awareness of where their water comes from and where they consume the resource, perhaps even without realizing it. ©

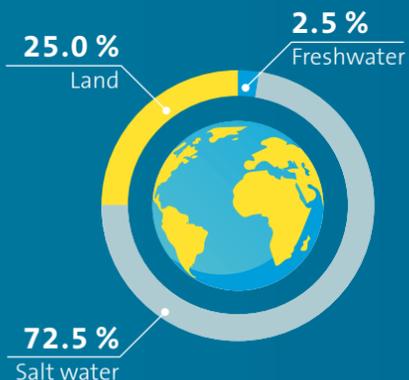


WATER CONSUMPTION FROM HOUSEHOLD ACTIVITIES



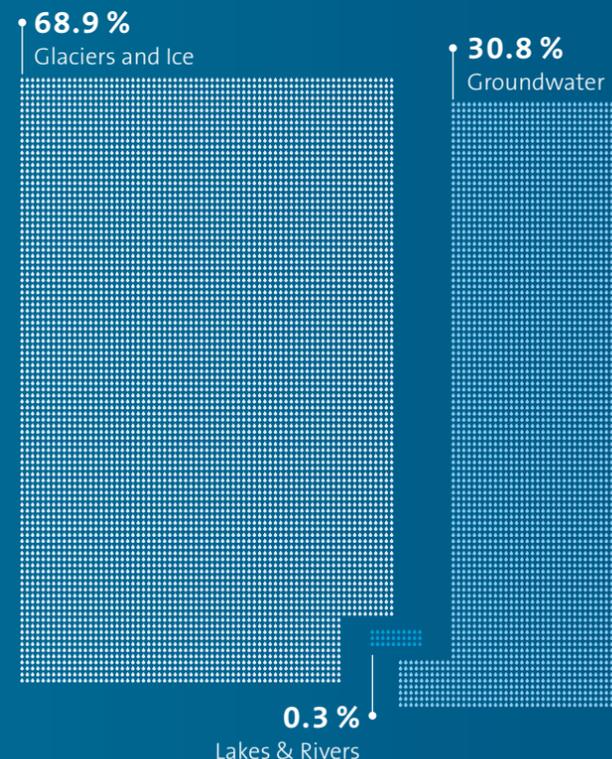
FACTS AND FIGURES THE WORLD'S WATER

A PRECIOUS COMMODITY



Source: UNESCO (1999).

THE EARTH'S FRESHWATER



Source: UNESCO (1999).

SURPLUS OR SHORTAGE

Quantity of precipitation per year
1 drop \triangleq 50 mm of precipitation

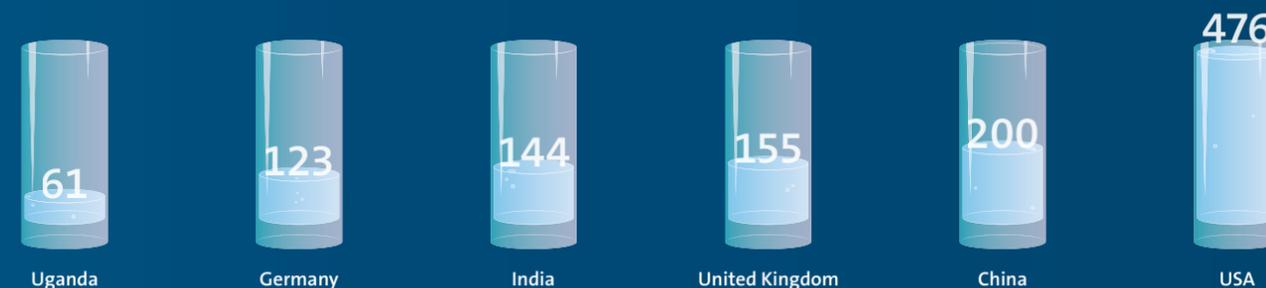


WHAT WATER COSTS IN ... (in euros per cubic meter)



*For consumption per month. Source: GWI, Statista and Wikipedia.

DAILY WATER CONSUMPTION PER CAPITA in liters in households in large cities



Source: IWA Network.

WATER CONSUMPTION BY SECTOR



Source: Aquastat (2012).

VIRTUAL WATER FOOTPRINT

How much water is really used?

Water consumed during the manufacture of products is known as "virtual water." Water footprints take this indirect use of water into account by showing how much water our lifestyle demands. This also includes water that is not consumed in the country itself. When we import goods, we are consuming water in other countries. On average, a person uses 1,240 cubic meters of water per year. In Germany, the figure is 1,545 cubic meters, which works out to 4,230 liters per day.



Source: www.waterfootprint.org

Source: <http://www.factfish.com/de/statistik/durchschnittliche%20niederschlag%3A4age>

Source: waterfootprint.org, Statista, Water Footprint Network.





WATER FOR THE BRAIN



People say drinking water promotes concentration. That's no surprise.

After all, we are largely made of water, and that is especially true of our brains. But is it really that simple? What is the connection between water and the capacity to think? A hunt for clues.

“Drink some water – it’s good for the brain.” Every child has likely heard this – or something very much like it. Water and the brain are two entities linked – on more than one level. First of all, our brains are 80 percent water. They absorb energy and nutrition through it. About one-third of our metabolic energy reaches the brain during periods of rest. Even the poetic term “thirst for knowledge” establishes an interesting connection with water on the level of speech and thought. Our brains are thirsty, both literally and figuratively.

THE PROBLEM WITH THICK BLOOD

But what does that mean? Does drinking actually promote concentration? One thing is clear: if you drink (excessively) small amounts of water, you can expect your ability to concentrate to decline. If blood has too little water, it becomes thicker and flows more slowly. Oxygen and nutrients are no longer transported rapidly enough, and your body has to work harder to pump blood through your veins – it is forced to deprive other parts of your body of energy and strength. The brain, for example. Your pulse and body temperature rise. So drinking enough water is important, and not just for your health and well-being.

Circumstances become dire when people cannot meet their need for water long-term. Child mortality has certainly declined over the years worldwide. But the number of children suffering from a shortage of water has risen. If they cannot cover their daily water needs, the development of their brain suffers. That means 200 million children under the age of five will not be able to fully develop their capacities long-term. Increasing the supply of water worldwide would not just reduce suffering – it would unleash human potential as well.

THE SUBTLE INTELLIGENCE OF THIRST

Drinking water is good for the brain from a number of standpoints. Unfortunately, some of these benefits fall away when water supplies are abundant. Drinking more water offers no advantage if you are already well hydrated. The effect is actually the opposite. The body has to work harder to deal with surplus water that it doesn’t need at the moment – and to limit the risk of salt loss. There is a set of interesting reactions: swallowing becomes more difficult. With excessive water intake, a number of organs switch to low gear, including the brain. Contrary to common belief, it is indeed possible to drink too much water and to shift into so-called water intoxication (hyperhydration). The amount of water intake should not exceed 6 liters, experts advise, and some consider 3 liters to be a sensible limit and a good rule of thumb.

Or to put it another way: human thirst is a highly effective, refined indicator. It is the body’s subtle mechanism telling us when to take in fluids and how much. Experts are skeptical about the still widespread rules of thumb that urge people to drink a certain quantity of fluids each day. They apparently have their origin in a misunderstanding. In reality, the sensible quantity of fluids and the limit are highly dependent on a range of factors, including body size, climate, and, quite logically, the level of physical exertion. The problems arise when our thirst mechanisms let us down, for example, in old age. In short, as long as we can quench our thirst at will at any time, it is not an alarm signal but rather a useful and important aid and a very refined mechanism. At the same time, it is imperative to confront thirst worldwide. And those who do not suffer from deprivation should listen to their inner voice more often – and pay attention to the thirst that they feel. ©



THE WATER FLOWS FROM THE SOUTH

Beijing and northern China are suffering from a continuing drought. Since 2014, drinking water has reached the Chinese capital through a system of canals from the South. That is one reason why the city is just beginning to practice water conservation.

The drought in the Beijing region didn't leave the Chinese capital high and dry last winter – thanks to a reservoir in Southern China. Not a single raindrop or snowflake fell on the city between October 23, 2017 and March 17, 2018. It was the city's longest drought since weather records began to be kept. But Beijing residents didn't have to economize because water continued to flow from the South. The so-called South-North transfer is the largest water diversion project in history. The costly liquid has been pumped from China's rain-soaked South to its arid North over

two routes: from the Danjiangkou reservoir to a Yangtse tributary, and from the old imperial canal into the Yangtse port city of Tianjin. According to the water control authorities at Danjiangkou, more than 3 billion cubic meters of water flowed from the reservoir to Beijing through March 2018. At its maximum capacity, the North-South project can send up to 25 billion cubic meters northward, year in and year out. The city uses it to cover 70 percent of its drinking water needs and simultaneously solve a major problem: the water table beneath the city has been falling

for years – because water has been drawn from its groundwater and from surrounding reservoirs. It has now been able to shut down about 330 wells.

SCARCE DRINKING WATER RESERVES

Nature has endowed China with too little water. The country represents about 20 percent of the world's population but has only 7 percent of its drinking water reserves. And even they are distributed unevenly. "Half of the population lives in the North – and this half has less than 20 percent of the country's water resources available to it," said Ma Jun, Director of the Institute of Public & Environmental Affairs (IPE) and one of the country's foremost water experts. Wide expanses of the Northwest consist of grassland, semi-deserts and deserts. Grain farming around Beijing and in northeast China has only been possible with irrigation. The region's population and economic output are growing, boosting the demand for water. Urbanization is also increasing: at the end of 2017, Beijing had about 21.7 million residents.

The water shortage is man-made in many areas. Throughout China, this scarce resource is contaminated to an unparalleled degree. More than two-thirds of the groundwater in the north Chinese lowlands is not suited for human consumption, according to a study by the National University of Singapore. In many

NORTH-SOUTH WATER TRANSPORT
Drinking water in China's capital Beijing arrives through several canals from the country's rainy South.



cases, the water from streams cannot even be used in industry. And like many developing countries, China does not practice modern water management. Low prices for private consumption and agriculture are almost an invitation to the wasteful use of water.

“Too much water is still wasted in Beijing,” Ma said. “People do not have a well-developed awareness of the problem. They resist the idea of higher water prices.” Most of Beijing’s residents live in large housing complexes. They often consist of several high-rises, and the management controls their water systems. “Hotels, restaurants and schools consume too much water,” Ma said.



Daily consumption of drinking water per capita in China (in 2016)

438 liters

“The faucets leak, and, the toilets at many sites actually have a water conservation option, but it usually doesn’t work.” Leaks in the water lines are a huge problem. According to data from the Chinese Network to Monitor the Economy (eoo), about 18 percent of the water in Chinese cities is lost due to

leaks. Moreover, all newly built housing complexes in Beijing have theoretically had to recycle their wastewater on their own for years. But the systems usually don’t work very well. And for its urban “greening” programs, the city has often turned to plants and lawns that need irrigation.

SAVING WATER HAS TO BE WORTH IT

In China as in other countries, economic incentives work the best. They are being introduced gradually – in the industrial sector, at least. For example, at the end of 2017, the water taxes for the manufacturing sector were sharply increased in several northern provinces. The prices that factories are paying for water are rising exponentially there, said Gan Yiwei, a water expert at Greenpeace in Beijing. “The more a factory consumes, the higher the price per liter.” Hebei province, which surrounds Beijing and is home to heavy industry and many coal-fired power plants, was selected as the pilot region for the tax. The China Daily newspaper describes natron producer Tangshan Sanyou Group, which previously extracted large quantities of groundwater, as one of the success stories. The company now pays six yuan instead of the two yuan (the equivalent of about 90 US cents versus 30 US cents) per cubic meter of water. With the help

of unspecified water conservation measures, its natron plant reduced the share of groundwater it uses from 60 percent to less than 10 percent. The tax has meanwhile been levied in nine other provinces, including Beijing.

LARGE BACKLOG

But Gan considers coal to be the biggest problem. From mines to power plants and chemical facilities, the sector is highly water intensive. In 2017, researchers from Greenpeace East Asia estimated that a reduction in the coal sector’s overcapacity would save enough water to supply 27 million people with drinking water. Regions with water shortages – of all places – will account for 60 percent of the coal industry’s water consumption in 2020. This explains why the Chinese government has stopped the construction of new coal power plants. The capital has closed its



Beijing drinking water consumption (in 2012)

3.6 billion m³

four coal-powered facilities and is turning to natural gas, which will save large volumes of cooling water.

China intends to cap its nationwide water consumption at 670 billion cubic meters by 2020. That figure was 604 billion cubic meters in 2016. To be sure, China is continually investing in new sewage treatment plants, but 60 percent of its industrial wastewater still reaches the environment in untreated form. So the country still has a long way to go. The U.S. market research firm BCC Research expects the market

for wastewater treatment products – pumps, valves, pipes, chemicals – to grow 6.7 percent a year to more than \$58.2 billion by 2022. The Chinese Environment Ministry recently announced that it was incorporating incentives into the pricing system for wastewater. Furthermore, it has begun supervising the South-North project – a clear sign that new measures are needed. One problem: the falling water level in the Danjiangkou reservoir is increasing sedimentation.

“China can still learn a great deal from models abroad,” said Ma, the water expert. He points to Singapore’s successful urban water economy, the low water consumption in Israeli agriculture, and Japan’s efficient industrial water use. Modern water conservation technologies are certainly available in China. But the know-how and the will to use them are often lacking – as is the funding. For example, China plans to introduce drip irrigation across the board in China. But Gan of Greenpeace asks: “Do farmers really want to use this time-consuming process? And who’s going to pay for it?” There aren’t many prosperous farmers in China.

Meanwhile, the North continues to rely on the country’s water transfer project. If it proves insufficient, Beijing will largely get preferential treatment. The surrounding provinces will be left high and dry. The experience of the coal-rich province of Shanxi shows this. Unlike Beijing, it had to ration water over the winter. ©



WATER CONTAINERS

In northern China, more than two thirds of groundwater is unfit for human consumption. Many inhabitants therefore purchase their drinking water in bottles.

COAL INDUSTRY
In areas of China with acute water shortages, the enormous water requirements of coal-fired power plants are aggravating the situation.





WHO OWNS THE WATER?

Fresh water makes up only 3% of the Earth's water supply. Over 20% of that small amount is found in the five Great Lakes of North America, an ecosystem in delicate balance. As the world get drier – and thirstier – fresh water faces ever more challenges to its stability and quality. As we look to the future, who will use this water? In what ways? And how can it be protected?



250

different species of fish can be found in the lakes, with 65 million metric tons caught there every year.



22,681

cubic kilometers of water make up the combined volume of the Great Lakes.

From space, the Earth is a very blue planet. In 2018, water covered 71 percent of its surface. But only 3 percent of this life-sustaining resource is fresh. The five North American Great Lakes – Superior, Michigan, Huron, Erie and Ontario – hold more than 20 percent of the world's fresh water and 84 percent of North America's fresh water. They span eight U.S. states and two Canadian provinces, covering more than 750 miles (1,200 km) and providing water for consumption, transportation, power, recreation and industry.

The lakes are inland, non-saline oceans in their own right, and they face many threats. Industrial, commercial and agricultural operations, municipal wastewater systems, environmental issues and invasive species are all taking their toll. Consider just two of the latest challenges: a Swiss food and beverage company's Michigan plants have been given preliminary permission by the state to increase groundwater withdrawals from 250 to 400 gallons per minute in order to increase their production of bottled water. More than 80,000 citizens objected at local hearings, stating the plan will irreversibly impact the ecosystem.

Just 400 miles away, in Racine, Wisconsin, an Asian LCD screen manufacturer has been given preliminary approval by the state of Wisconsin to withdraw 7 million gallons of Lake Michigan water per day to support its operations. Environmental groups and community residents opposed the request, citing overuse of public water by a private company as a primary objective. These cases, and other diversion challenges like them, raise profound questions about water rights and protection in the Great Lakes basin. As the world becomes more thirsty, who gets to use the water and for what?

WHOSE WATER IS IT?

Historically, the Great Lakes have belonged to the people in the region – residents of the U.S. states of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin and the Canadian provinces of Ontario and Quebec. Their legal management and protection has fallen to both countries. The Great Lakes-St. Lawrence River Basin Water

Resources Compact (GLC) is a bi-national legal agreement that regulates the Great Lakes basin. Drafted in 1983, it was ratified in 2005 and legally recognized by the U.S. and Canadian governments in 2008. The GLC mandates how, and how much water may be drawn from the region. It also regulates maintenance of the lakes' quality and safety for consumption and recreation. In addition to the GLC, Canada and the United States have adopted the Great Lakes Water Quality Agreement (GLWQA) to assess how well the lakes are being protected. Oversight of the agreement is managed by International Joint Commission (IJC).

"Coordinating the programs between two countries, eight U.S. states and two Canadian provinces is a major challenge," said Frank Bevacqua, an IJC spokesman. "But since the waters, fish and other components of the Great Lakes ecosystem do not recognize the international boundary, the need to tackle issues in a coordinated manner has helped to focus the attention of the two countries. "The GLWQA has also fostered collaboration among citizen organizations in both countries to build a genuine bi-national Great Lakes community. The level of co-operation is quite remarkable," he added.

IMPACT OF COMMERCE AND INDUSTRY

The Great Lakes, and the waterways connecting them, have been critical to commerce and industry since the first settlements in the region were established around 1600. In 1959, the opening of the St. Lawrence Seaway provided Great Lakes access to ocean-going freighters and worldwide trade. This vast, accessible fresh water source supports multiple industries including automotive, steel, paper, chemicals and consumer goods. Commercial and industrial growth in the region has driven urban and residential growth. According to a Business Insider 2017 report, if the Great Lakes region were a country, it would rank third-largest in the world, with a GDP of \$6 trillion. Just one example: 65 million pounds of fish are harvested annually from the lakes and sold worldwide, contributing more than \$1 billion a year to the regional economy. Sport fishing and related tourism contribute another \$4 billion-plus per year.



200 million

metric tons of freight are shipped across the Great Lakes every year – a critical economic factor.



244,383

square kilometers of water surface make the Great Lakes the largest freshwater surface on Earth.



57

meters down goes Niagara Falls. The Niagara River connects Lake Erie and Lake Ontario.



405

meters deep is the largest lake at its deepest point. That is about 135 stories.

“We don’t believe it’s either/or when it comes to business in the Great Lakes region – either a safe ecosystem or regional business,” said Jennifer Caddick, Vice President, Communications, at the Alliance for the Great Lakes (AGL), an advocacy and research organization devoted to the welfare of the Great Lakes. “We expect that companies recognize the value of this resource – to them, and to the people of the region – when they choose to do business here, and that they will be thoughtful caretakers of the environment.”

Industry and commerce are part of the ecosystem’s history, Caddick added. “It’s not a positive or a negative, it’s just a unique situation. (And) there is wide-spread, international, bipartisan support for preserving the fresh water in the region. People understand that this natural resource is a one-time deposit from the glaciers.”

Indeed, many commercial companies, including breweries and wineries in the region, are acutely aware of what’s at stake if Great Lakes water levels or quality drop. “The Great Lakes exist as a veritable natural-resource jackpot for the hundreds of breweries located along its shorelines and in its basin,” Mathew Powers recently noted in an article about Great Lakes breweries. (“Great Beer, the Great Lakes and the Ties that Bind,” January 2018, craftbeer.com.)

In the essay, Powers noted that regional breweries are not only concerned with making great beer, but with preserving access to safe drinking water as well. Many breweries have imposed self-regulated water conservation usage standards as part of their sustainability efforts. Nonetheless, growing commercial and industrial usage have increasingly put interest groups at odds. While experts from the IJC and AGL agree that current water agreements, if fully carried out, are sufficient to protect the lakes, they also acknowledge some issues, like groundwater withdrawals and water diversions, are becoming more pressing.

“The GLC is a solid agreement and covers all the ‘big picture’ issues. It has firmly closed the door on major issues like discharges and diversions of water from the region,” Caddick said. “But there are some issues that remain open to debate.”

“Some issues require more attention,” Bevacqua agreed. “For example, groundwater aquifers that connect the Great Lakes are being withdrawn at an unsustainable rate in certain areas.” As a result, a concerted effort to include more voices in the legislative decision-making process surrounding Great Lakes water usage was launched. In June of this year, Michigan Governor Rick Snyder, signed a package of laws that create three private sector panels made up of non-governmental stakeholders, including regional businesses, to join in Great Lakes decision-making with the Michigan Department of Environmental Quality (DEQ). The Michigan Chamber of Commerce advocated for passage of the bills into law.

“It’s all about transparency in the process,” said Jason Geer, the Michigan Chamber’s Director of Energy and Environmental Policy, in public debate over the bills in May. “Right now, the rulemaking process is very closed and DEQ staff-centric.”

MORE THREATS TO ADDRESS

The Great Lakes ecosystem, a delicate mix of habitats that shelter more than 3,500 species of plants and animals, is also threatened by environmental degradation and invasive species. Data collected by public and private research agencies indicates that temperatures in the Great Lakes basin have increased 2 to 4°C during the past 10 years due to global warming. Warmer temperatures affect lake levels by reducing runoff and increasing evaporation. At the current rate of warming, lake levels will fall a half meter during the next decade. The Great Lakes have also been heavily damaged by more than 180 invasive and non-native species which have reproduced, spread across the system, displaced native species and destroyed habitats and food chains. And municipal and agricultural pollution increasingly pose problems for the lakes. Experts note that the wastewater treatment infrastructure in most regional cities needs to be repaired and upgraded to keep pace with water usage and storm water runoff. But contaminants from wastewater and agricultural runoff are difficult to track. There is no single pipe that leads to the source, they agree.

OPTIMISM DESPITE THE CHALLENGES

Despite serious obstacles, the agencies and individuals tasked with protecting the Great Lakes remain vigilant and optimistic. They have to be for future generations. Long-term sustainability of a healthy Great Lakes ecosystem will depend upon a strong collaboration between businesses, agricultural interests and governments, said David Naftzger, Executive Director of the Conference of Great Lakes and St. Lawrence Governors and Premiers, an organization that supports and advises the elected leaders of the states and provinces that border the Great Lakes watershed.

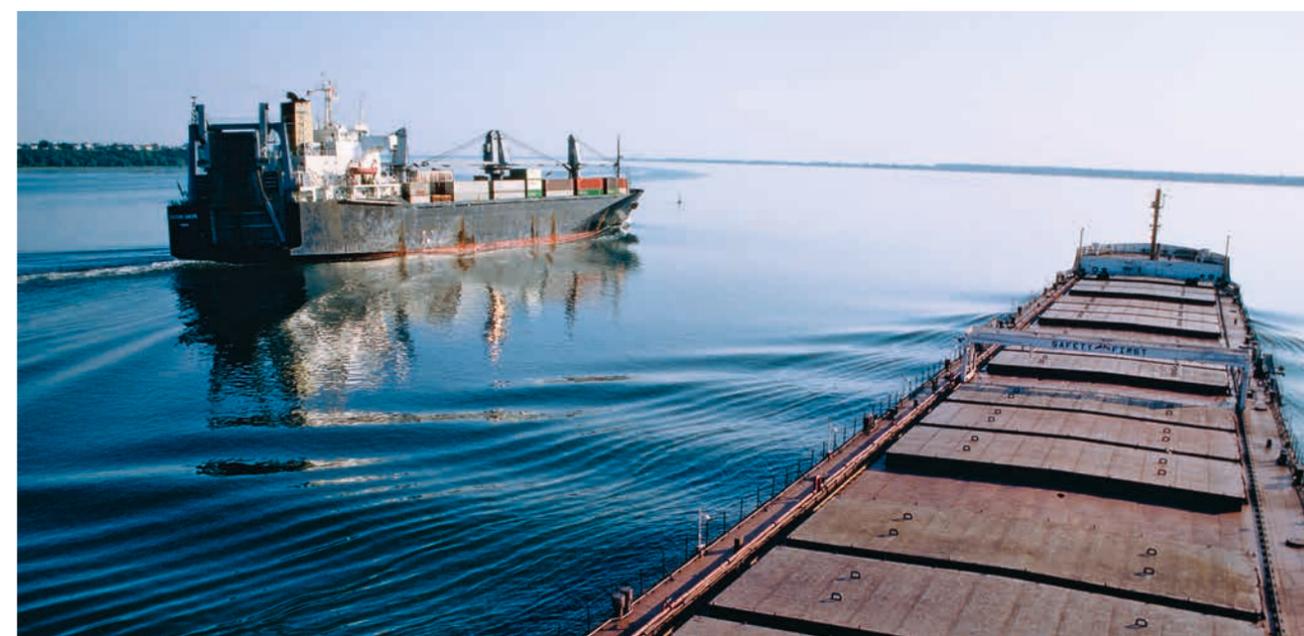
“Business and community goals for the sustainable use of the Great Lakes are really the same,” he said. “Healthy water is necessary for communities as well as for businesses to protect the competitive advantage that the Great Lakes offer.” Naftzger, an avid environmentalist, emphasized that in order

to achieve successful, long-term sustainability in the lakes, “everyone involved must look to the past, as well as the future. In addition to preventing pollution, long-term ecological restoration programs must be put into action – and supported, to eliminate legacy pollution,” he said.

“The Great Lakes are a global treasure,” Caddick agreed. “As the world warms, we will see more pressure in the region, but everyone involved is committed to doing the right things. More and more people – from businesses and the communities – get involved every day. This high level of concern makes for an ultimately positive outlook.” “The experience in the Great Lakes basin shows the necessity and value of working together among the various political jurisdictions, communities and sectors of society,” Bevacqua agreed. “It’s an arduous process, requiring long-term commitments, but basin residents demand nothing less – the Great Lakes are the heart and soul of the region.” ©

LAKE SUPERIOR

Since 1959, the Great Lakes have had access to the Atlantic Ocean and thus to world trade.





THE COUNTRY LIFE

Our ideas about agricultural professions often date back to the 19th century. But how do modern farmers work?

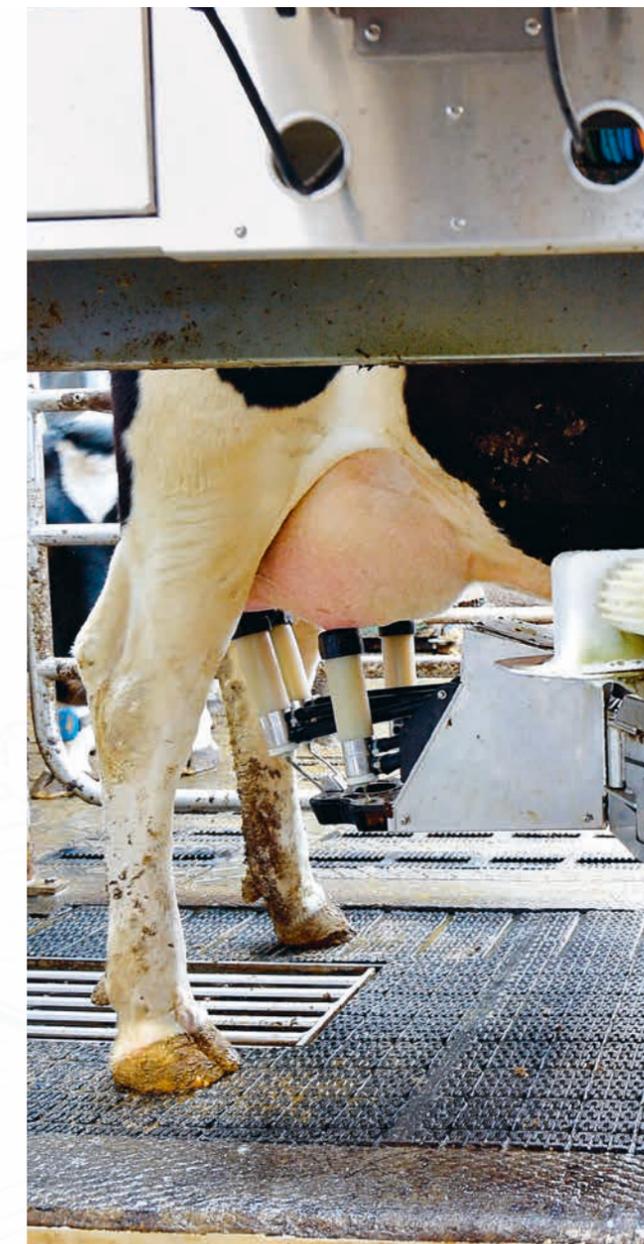
DAIRY INDUSTRY IN AUSTRIA

Koppensteiner Organic Dairy Farm

Robots on an organic farm – are they really a good fit? Two robots are working out quite well on the Koppensteiner organic dairy farm in Lower Austria. One feeds the cows, and the other milks them. For dairy farmers Silvia and Christian Koppensteiner, ecological farming and advanced technology are no contradiction. On the contrary, thanks to the robotic milking, their 68 cows are milked precisely when they want to be. The robot is installed in its own stall, and the door to it is open to the animals around-the-clock. And it knows the herd – in detail. When one of the cows walks into the stall, she is identified with the help of a transmitter in one of her front hooves. The robot finds the teats in one try, and it measures the quantity of milk during the process – along with its fat, protein and lactose content. Measuring the conductivity of the milk, it can even assess whether the cow might have an inflammation in a teat, and quickly sound the alarm. Life has become a lot simpler since robots and the Koppensteiner family began caring for the animals together. Milking and feeding times no longer dictate the family's life rhythm. Of course, there is always something to do. Fortunately, everybody pitches in – including the robots.

7,000 LITERS OF MILK

That's the quantity that one cow on the Koppensteiner bio-dairy farm produces annually. Thanks to their robots – which now handle milking and feeding – the Koppensteiner family can quickly market their products themselves. They deliver their bio-milk throughout the region over a period of three to four hours a day, which is precisely the amount of time that the use of robots makes available to them.



AGRICULTURAL MILESTONES

1800

Before mechanization, the daily periods for resting and feeding workhorses are key factors setting the daily rhythm of work on the farm. The first wave of mechanization starts out on large farms in the United States with threshing and harvesting machines.

1840

Justus von Liebig formulates the Law of the Minimum, which holds that the soil's productivity can be increased by adding fertilizers containing mineral nutrients. The required quantity of nutrient depends on the plant and the variety. If the nutrients are only present in tiny quantities, the size of the harvest is limited. His insights into agricultural chemistry revolutionize farming.

1902

Hart-Parr is founded in Iowa, becoming the first company in the United States and indeed the world to specialize exclusively in tractor production.

1908

Fritz Haber, who will later become a Nobel Laureate for chemistry – receives a patent for a process to synthesize ammonia, which makes it possible to artificially manufacture the chemical. The invention of mineral fertilizer promotes the industrialization of agriculture, first in Europe and North America and later in the developing world.

1960s

The mechanization of farming makes it possible to apply fertilizers and pesticides regularly on a large-scale, enabling new, more productive varieties of wheat, corn and rice to be introduced. New cultivation methods designed to increase agricultural output gradually find their way to developing countries (the “Green Revolution”). Global food production will triple over the next 50 years.

GROWING POTATOES IN THE NETHERLANDS

Van den Borne Aardappelen

Potatoes and data are the most important crops from Jacob van den Borne's fields. His philosophy is straightforward: “The smarter the farmer, the more completely he knows his fields.” Van den Borne likes to delve deeply into the data. Measuring and analyzing are as much a component of his daily activities as riding a tractor.

The Dutch potato farmer has 500 hectares of land under cultivation. And this highly detail-oriented farmer painstakingly monitors the plants' growth on each of his widely scattered parcels, down to the individual tubers. He is interested in everything, from the soil's nitrogen content to the amount of shade falling onto plants. Meanwhile, he knows the air temperature prevailing at specific fields, the

humidity, and even the temperature of the soil. This involves sending drones and quadcopters out over his fields, integrating sensors of all kinds into his farm machinery, and scanning his soils. He shares his harvest of data with universities and interested parties, knowing there is always more to learn.

53 TONS OF POTATOES

per hectare. That's the quantity that Jacob van den Borne harvests from his parcels, and sometimes even more. Worldwide, potato farmers typically grow half as much on their fields. With the help of the latest technology, which he optimizes to meet his needs, he conserves fertilizer and water as well.





HIGH-VALUE CROPS IN THE USA

Wildy Family Farm

David Wildy inherited the land from his father, who in turn acquired it from his father. On nearly 5,000 hectares in northeast Arkansas, in the Southern United States, he grows cotton, corn, soy, peanuts and wheat. Working with Arkansas State University and the USDA Agricultural Research Service, he found that he could reap a harvest of useful insights about growing crops on his farm.

The highly practical research ranged from soil mapping to water management with the help of sensors and remotely controlled pumps. At times, the scientific analyses could slow his operations – for example, when the control areas are planted and everything is carefully measured. But Wildy believes the long-term gains in knowledge are what counts. Two years ago, he was honored as Farmer of the Year in Arkansas – for practicing what he preaches: farming his land responsibly and with foresight so his children and grandchildren can continue the family tradition.

567 KILOGRAMS OF COTTON FLUFF

per acre (4,047 square meters). That was the yield on the Wildy family farm in 2017. And then there was the 5.6 tons of corn, 1.6 tons of soybeans, 2.8 tons of peanuts and 1.9 tons of wheat. But the strong harvests have not led Wildy to neglect his social responsibilities. He values environmentally friendly farming and conserves energy and water resources as much as possible.

YIELD INCREASES FOR CORN, WHEAT AND RICE 1961 – 2014



Corn

6.9 t/ha

2.2 t/ha

Europe

10.7 t/ha

3.9 t/ha

USA

2.6 t/ha

1 t/ha

India



Wheat

4.3 t/ha

1.3 t/ha

Europe

2.9 t/ha

1.6 t/ha

USA

3.6 t/ha

0.9 t/ha

India



Rice

7.3 t/ha

4.2 t/ha

Europe

8.5 t/ha

3.8 t/ha

USA

3.6 t/ha

1.5 t/ha

India

● 1961 ● 2014



Read more about this topic online at www.fst.com/markets/mobile-machinery



ELECTRICALLY POWERED AGRICULTURAL MACHINERY

The electrification of farm equipment is still in its early stages. But major companies such as John Deere and the vehicle supplier ZF are already working on hybrid and all-electric powertrains.

And they are not just focusing on tractors.



Electric attachments could become the driving force behind electrification in agriculture.

Accurate down to the centimeter, a planting machine sends corn kernels to a series of points in the soil. The equipment, which plants individual kernels, spreads its supply of seeds in eight parallel rows as a tractor moves resolutely through the fields. Electric servo drives ensure that each individual kernel is accelerated to the exact speed that allows it to hit the ground at a relative velocity of zero despite the machinery's forward motion. "Without electric drives, we would never be able to achieve this precision," said Dr. Peter Pickel, a university professor who serves as deputy director of John Deere's European Innovation Center in Kaiserslautern. "It is only the high level of control possible with electric motors that allows precision planting in the first place," he said. The deliberate thinning of the plants has a number of advantages. First, none of the seed supply goes to waste. Second, the farmer can reduce his level of pesticide use. Or, the mechanical preparation of the soil can eliminate the need for it. Pickel believes the electrification of farming technology starts with the tools used in agriculture. "Farm equipment is nothing more than a mechanical tool on four wheels," he said. "Over the last few decades, hydraulic drives have also been replaced by electric motors in many cases."



PRECISION AIR
SEEDER:
Electric servo drives
ensure maximum
precision during
sowing.

Tractors' internal combustion engines are being replaced much more slowly. As with cars and commercial vehicles, the storage capacity of the battery is the main constraint. A tractor with a motor output of 380 kilowatts – the level needed for cultivating soil – requires nearly 2.3 megawatt hours of electrical energy to operate for twelve hours at about 50 percent of capacity. A state-of-the-art lithium ion battery providing this amount of energy would weigh about 15 tons, according a study that Pickel commissioned. Despite the physical laws that pose obstacles to a rapid transition, he and his team have been working for more than ten years on hybrid and all-electric drives. "Long-term, we will only achieve complete sustainability if we stop using fossil energy sources," he said.

USING YOUR OWN GREEN ELECTRICITY

Agriculture accounts for 24 percent of global greenhouse gas emissions. Even if they cannot be traced back entirely to diesel fuel, there are only two options for a climate neutral tractor: either the

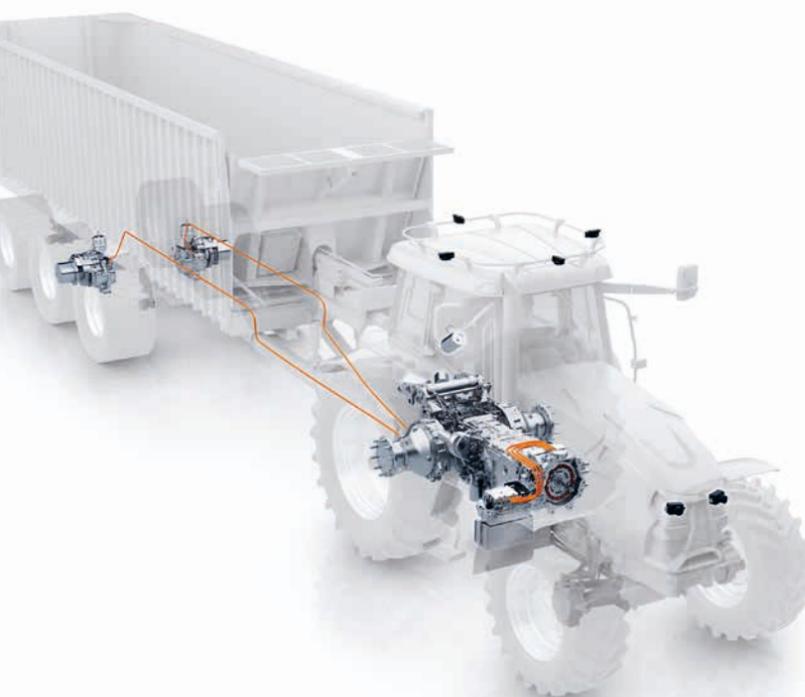
farmer fills his tank with biofuels or he uses renewably generated electricity. The latter option seems natural since more and more farmers are producing their own electricity. Solar units on barns and stables are already a common site in many developed countries. A large share of land-based wind turbines is located on the outskirts of farmland. So Pickel is promoting a new idea: instead of equipping tractors with fixed batteries, he would swap them out. This would involve mounting several batteries at the farm's electrical connector and charging them when the sun is shining or the wind is blowing. Before the tractor departs, a battery weighing only about a ton is loaded onto the tractor and connected to the electric drive system using a standard plug connector. The extra weight due to the battery is not a problem since even conventional tractors need a counterweight for many applications. "This type of solution is not only less expensive but helps to take pressure off the public grid," Pickel said. The concept was due to be tested late this year at a farm in Allgäu in Southern Germany.

The first all-electric tractor from John Deere made its appearance in 2015, and still had a complete battery on board: the SESAM (Sustainable Energy Supply for Agricultural Machines). The approach was straightforward: the tractor did without an internal combustion engine, transmission, emission treatment system and fuel tank and turned to batteries with an overall capacity of about 110 kilowatt hours instead. The electric motor – which was quite compact compared to the battery – operated as the main powertrain on the rear axle and generated a maximum output of 130 kilowatts. A second electric motor, also with 130 kilowatts, drove the power takeoff shaft and hydraulic system. When acceleration was needed, the two motors could be interconnected. “We’ve gained an incredible amount of knowledge during this project,” Pickel said. For example, the team determined the system’s actual energy consumption during a measurement trial. One important finding: the physical task itself only accounts for about 40 percent of the overall electricity consumption. The rest is dissipated in the drivetrain and accessories or in tire slippage. After the tractor ran for an hour and a half, its battery, on average, was totally drained. Meanwhile, John Deere is working on a new technology demonstrator that will incorporate its findings.



FULL ELECTRIC TECHNOLOGY TRACTOR “SESAME”: 110 kWh batteries fit under the hood.

But it will be a while before diesels disappear from farms – notwithstanding the accelerated research. “We won’t see all-electric tractors in this performance class in series production before the year 2030,” Pickel said. But small tractors in the 50-kilowatt class, which will mostly operate on farms, could be running solely on battery power well before then.



“INNOVATION TRACTOR” FROM ZF: The electrically driven wheels give the trailer more traction.

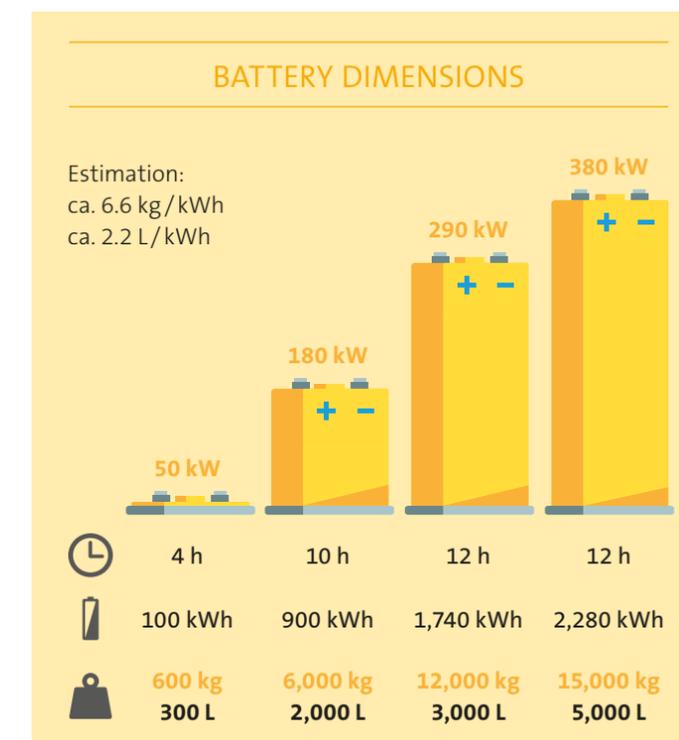
only depends on the crops being grown – it is also a function of the size of the farming operation. The trend to ever-larger acreages has led to an increase in the proportion of travel on roads. “At the component level, we consistently find synergies with road vehicles,” Stempfer said, although he added the entire drive system must always be optimized for farm use.

AUTONOMOUS FIELD ROBOTS

Farms will seem very different if the multipurpose tractor is replaced by highly specialized field robots in the distant future. As they imagine a new age of farming, agricultural engineers envision small, autonomous equipment swarming over the fields and targeting each individual plant. Below a certain size, the diesels lose their edge in power density, and electric powertrains would become the propulsion of choice. So far, the new approaches can only be found in research projects. No one can really say whether these seeds will take hold. ©

Farm implements could prove to be the real drawing card for electrification. With its “Innovation Tractor,” ZF is betting on an electrically driven trailer axle. Gerhard Stempfer, who is in charge of work machine electrification at ZF, sees extra power as the advantage: “The extra power from the axle provides increased traction on loose or damp ground. This allows faster progress with less energy use and directly boosts the farmer’s productivity.” The tractor produces the electricity for the wheel hub motors on board. There is an electric motor operating solely as a generator on the transmission input shaft, delivering 70 kilowatts of maximum continuous power. The core arrangement is also found in hybrid commercial vehicles.

The electrical components themselves cannot simply be carried over from road vehicles to tractors and trailers used in harsh conditions out in the fields. The process starts with the design criteria. “There is no typical application for a tractor,” Stempfer said. In practice, the range of loads not





A CIRCULAR ECONOMY

Food, biofuel and environmentally friendly fertilizer – the vegetables growing in Planète Végétal’s fields fit each of these categories. The French vegetable producer has teamed up with the Carrefour grocery chain and Air Liquide, a producer of industrial gases, to develop a circular economy so leeks and carrots can undergo a multifaceted recycling process.

The young, deeply tanned man in the white T-shirt proclaims “Voilà,” looks around and grins. A co-worker slaps him on the shoulder. It’s done. After 27 minutes, his truck is set to leave. Within this timeframe, 113 kilograms of biogas have been pumped into its tank. He climbs into the cab and waves to the onlookers. The next vehicle is already pulling up, and more delivery trucks are in line, waiting to approach one of the four dispensers. The Carrefour logo is visible on one of the trucks, and the phrase “75 percent less CO₂ emissions” is inscribed in French on the trailer. “The truck emits virtually no fine particulates and makes much less noise than similar vehicles,” one of the drivers explained. “The biogas is a local specialty.” Wine typically comes to mind when the conversation turns to products from the Bordeaux region. But 20 kilometers (12.5 miles) southwest of the French city, the locals in Cestas, the site of the biogas station, are more likely to think about biofuel. The explanation lies just 3 kilometers (2 miles) away, at a farm called Pot au Pin.

This is where the vegetable producer Planète Végétal has teamed up with Carrefour and Air Liquide, one of the world’s biggest suppliers of industrial gases, to establish a circular economy – the first of its kind in France. Out in the fields, leeks and carrots are harvested and then delivered to supermarkets in the region. The fresh vegetables are transported to Carrefour stores in biomethane-fueled trucks, which fill up at the fueling station in Cestas. The fuel is produced locally, in a biogas plant amidst Planète Végétal’s fields. Waste from the production process and from the supermarkets selling the vegetables provide biomass, which is converted to methane. In turn, the waste from the biomethane plant becomes eco-fertilizer and is applied to the fields.

“Our fields, the biogas facility, the filling station – everything is in close proximity to keep transport distances short,” said Christian Letierce, Managing Director of Planète Végétal. It takes him just a few minutes by car to reach the biomethane plant.

Jérémy Ollier greets him at the fence. The 27-year-old engineer works for Air Liquide and supervises the methane production on site. Air Liquide has a 20 percent stake in the production facility, and Planète Végétal owns the rest. The raw material for the operation comes exclusively from plant waste and rye. The grain is planted in the fall and harvested in the spring. During this period, the fields had previously been kept partly fallow, but now the rye protects the soil from erosion during the winter. Combined with the plant waste, the material from the “cover crop” ensures that there will be enough biomass for methane production. “Each day, 40 tons of plant biomass are brought into the fermenter,” Ollier said. The fermenter, the heart of the operation, is a round, green building with a cupola-shaped roof. Inside, billions of microorganisms do their job in a space devoid of light and oxygen. At a constant 40°C, the biomass decomposes, primarily producing carbon dioxide and methane, plus a small amount of sulfur.

METHANE GAS FROM BIOMASS

“Slight deviations can knock the fermentation process out of equilibrium,” Ollier said. So the facility must be supervised around the clock. He shares shifts with his co-workers. If everything is working smoothly and the reduction process is complete, the raw biogas must still be processed before it can be used as a fuel. It is de-sulfured and dehumidified. Then the methane must be separated from the carbon dioxide. The gas is then “conditioned,” meaning that its composition is checked, its volume is measured, and it is odorized before being fed into the natural gas lines leading to the fueling station. But that’s not all: near the fermenter, there is an approximately 10-meter-long basin, one of several scattered over the complex, covered with a plastic sheet. Ollier points to the dark brown, crusted mass stored in the basin. “There is liquid up under the crust. That’s the waste, known as digestate, from the biomethane facility,” he said. At the end of the reduction process, the nearly odorless organic matter is left as liquid waste. This bio-fertilizer will soon nourish the leek and carrot plants out in the fields.

Christian Letierce is parking his vehicle at Planète Végétal’s farm. The pungent smell of onions is in the air. “We are one of the leading, independent carrot and leek producers in France,” he said. In 1980, he founded the company with his older brother François. Today their fields cover 1,400 hectares. On an especially good day out in the fields, Planète Végétal can harvest up to 250 tons of carrots and 40 tons of leeks and deliver them as far as 100 kilometers (62 miles) away. In their work, the brothers draw on their years of experience with vegetable farming. “But operating a biomethane facility was new territory for us,” the younger Letierce recalls. More than 300 guests came to the official opening of the production facility in June, he said with pride, and Carrefour calls the fueling station in Cestas a milestone in its sustainability strategy. The plant produces enough biomethane to fuel 100 trucks a day at the station. Other shippers use the locally produced biogas since Carrefour has opened the service to them as well.

The partners’ next goal is mainly to increase awareness. “If you happen to see leeks and carrots from Planète Végétal at a supermarket in our region, you don’t always realize the vegetables are part of a circular economy,” Christian Letierce said. At least, the truck drivers at the biogas filling station are clearly aware of that fact. And a growing number of Carrefour trucks bearing the inscription “75 percent less CO₂ emissions” are likely to be driving through the region in the future. The food retailer plans to increase its biogas fleet to 400 vehicles by the end of the year, and they will be traveling throughout country. ©

THE BENEFITS OF CIRCULAR ECONOMY



NICOLE SCHNEIDER

After graduating as a chemical engineer, Nicole Schneider joined Freudenberg Sealing Technologies as a Product Manager in the Process Industry division. For the Oil & Gas business, she moved to Houston, Texas, for three years to set up a materials laboratory. After returning to Germany, she switched to Business Development for the process industry. Schneider has headed that division since August 2016.



THE FULL FLAVOR

More and more kinds of beverages in every conceivable flavor vie for customers on the shelves of supermarkets.

This new diversity is placing huge demands on the facilities where the beverages are produced – from kettles and tanks, to pumps and tube systems, all the way to bottling systems. For example, the finely tuned flavors of individual drinks must not be allowed to mix with each other during the production process. In an interview, Nicole Schneider, Vice President Global Market Sector Process Industry in the Industrial Services Division of Freudenberg Sealing Technologies, offers insights on these issues.

MS. SCHNEIDER, WHAT MAJOR CONSUMER TRENDS ARE SHAPING THE BEVERAGE MARKET?

We are mainly seeing three trends. One relates to the high degree of flavor individualization, which results in considerable product differentiation. This can be seen in the expanding product lines of craft beers and brewed soft drinks produced. Another trend is consumers' growing health consciousness. Many of them want beverages produced with no preservatives or with the smallest possible amount – but they want drinks that stay wholesome as long as possible. Third, we are seeing more and more beverages made from solid ingredients. For example, to make a strawberry smoothie, the entire fruit is crushed into pulp. That leads to a higher proportion of solids in the drink.



Seals in the beverage industry come into contact with a wide range of flavors.

WHAT EFFECT DOES THIS HAVE ON THE EQUIPMENT WHERE THE BEVERAGES ARE PRODUCED? DOES THE PRODUCER HAVE TO BUY A NEW EQUIPMENT FOR EACH NEW PRODUCT?

Normally, new product varieties are produced in the existing facilities. Of course, this results in more frequent product changes, which means that the seals in tanks, tube systems and bottling facilities come into contact with significantly more flavors. With this in mind, operators have to take even greater care to ensure that the flavors are not trans-

ferred, that seals do not absorb specific flavors from previously processed drinks when the product is changed in the bottling facility, and that they do not reach the next product being processed. When a brewed, lemon-flavored drink is bottled, there must be no flavor transfer into the regular beer flowing through the tubing.

HOW CAN THE TRANSFER OF FLAVORS BE AVOIDED?

The selection of the sealing material plays a key role. Basically, the seals used in the food industry as well as the drinks being bottled are made from organic compounds, so they have a certain material affinity, that is, their molecules are similarly constructed. That is why flavorings creep into some sealing materials and then diffuse out over a period of time. The use of highly inert materials – which do not interact with other substances chemically or physically – are a primary way to prevent flavor transfer. Freudenberg Sealing Technologies has developed the Fluoroprene XP family of materials to deal with these problems. The recipe for them is precisely calibrated to the requirements of the beverage industry.

DO THESE REQUIREMENTS BECOME MORE STRINGENT IF SMOOTHIES AND OTHER DRINKS WITH A HIGH PROPORTION OF SOLIDS ARE PROCESSED IN THE EQUIPMENT?

Definitely, since they lead to an increase in the mechanical requirements. The higher share of solids requires greater material rigidity to prevent abrasion. The material must also be highly resistant to tearing, so fruit cores, such as those in strawberries, do not cause a seal to rupture. The precise requirements may vary, but they must be taken into account when the seal material is selected. The geometry of the seal is also a factor when beverages contain solids. It must be carefully selected to ensure that an overlay of solid particles does not impair the seal's performance.

“TO ENABLE TRULY NEEDS-BASED MAINTENANCE, WE ARE WORKING ON SMART SEALS.”

YOU SPOKE ABOUT THE RISING AWARENESS OF HEALTH ISSUES AND THEIR DESIRE FOR DRINKS THAT USE PRESERVATIVES AS LITTLE AS POSSIBLE. WHAT IS THE EFFECT OF THESE CHANGES ON COMPONENTS AND EQUIPMENT?

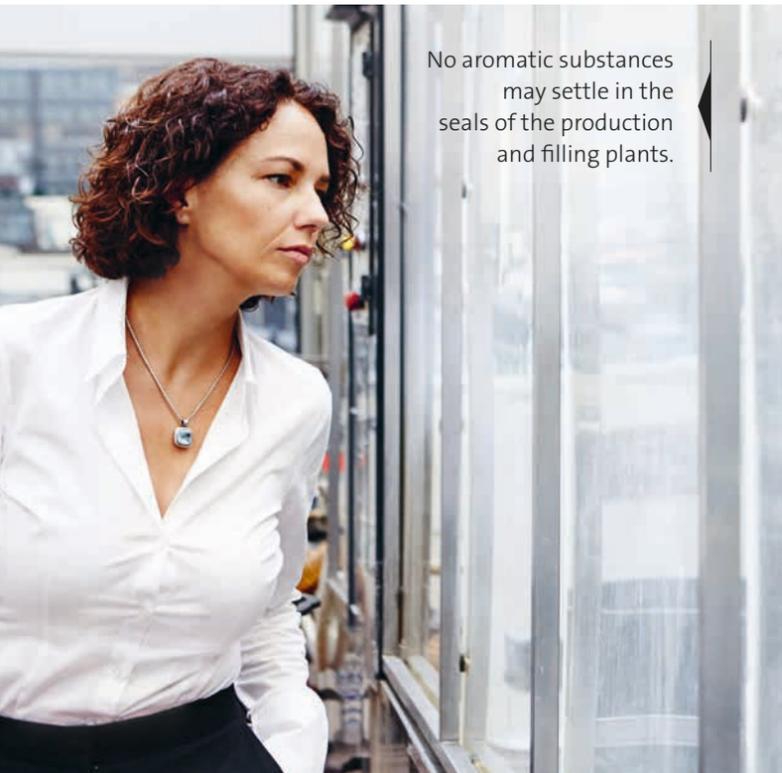
First of all, you have to ensure that the product changeover occurs as quickly as possible so the equipment can be utilized fully and efficiently. This has a direct impact on cleaning processes, which must be performed without manually removing individual components. These processes are known as “cleaning in place” and “sterilization in place” in the language of the trade, meaning that the cleaning and sterilization take place in closed equipment. In addition, when beverages that contain no or just small amounts of preservatives are processed, more aggressive cleaning agents are used. No bacteria can be allowed to reach the beverage. Still, the seals must be resistant to considerably

more aggressive cleaning agents such as acids and lye. There is another requirement for sterilization processes due to the customary use of steam at temperatures of 120° C or even 140° C in some cases. The seals must be able to withstand these high temperatures over the long haul. And since the cleaning takes place in a closed system, the geometry of the seal cannot have even the tiniest amount of dead space, that is, hollow areas and grooves with no function where contaminants or bacteria can reside. This approach is known as “hygienic design.”

WHAT SEALING CONCEPTS CAN THE BEVERAGE INDUSTRY EXPECT IN THE FUTURE?

We have been dealing with the issue of maintenance cycles very intensively. Due to the differentiation of the market, there are now many different maintenance strategies. Many large manufacturers replace their seals as a preventive measure. At smaller craft-beer breweries, there will be leaks if a maintenance interval runs too long. To enable truly needs-based maintenance, we are working on smart seals that are able to measure their own level of wear and report it to the operator in real time. At some point, there could be seals that are able to request a replacement on their own. We are going to work with customers to further develop these kinds of smart seals for Industry 4.0 applications, in line with the needs of the market. ©

Before a new beverage can be bottled, the bottling line must be thoroughly cleaned.



No aromatic substances may settle in the seals of the production and filling plants.

Read more about this topic online at <https://foodandbeverage.fst.com>



THE HIGH ART OF THE CRAFT

The craft beer movement has been sloshing onto Europe's shores from America since the early 2010s, and breweries are becoming ever more adventurous.

Beer sommelier, master brewer, entrepreneur. Max Spielmann is well-equipped to take over Braumanufaktur Welde from his father Hans. He is continuing a grand legacy. The venerable brewery, which was founded in 1752 in Schwetzingen, near Heidelberg, has been in the family's hands from the beginning. "Family-owned companies have it easier in a number of ways," Spielmann said. "They can think long-term. That makes it easier to reinvent themselves again and again." Here he definitely sees parallels to the global Freudenberg Group in neighboring Weinheim. But the wide, wide world, once depicted with sailing ships in commercials, hasn't been trendy since the craft-beer wave washed onto Europe's shores from America in the early 2010s. "The political and social norms of the 20th century have been dissolving, and people have lost their gravitational center," he said. "Now they're seeking a new orientation in their own regions and buying regional products. They want to know where their food comes from."

The consumers' need to know the provenance of their goods is a key reason for the success of craft beer, according to Spielmann, who worked for Heineken in Mexico and Amsterdam after completing his graduate studies in business administration at TU Munich. "Craft beer is the personification of its maker," he said. "People want to see the master brewer. They want to be able to reach out and touch him. They don't want to see any more anonymous commercials on TV. Instead, they want to get advice at a tasting – especially from guys with

tattoos and full beards" After all, a key factor in the success of craft beers is their taste.

Spielmann wants to offer his customers these experiences – with a pale ale perhaps made with an American aroma hop, known as Citra, that unfolds with accents of lemon, lime and wild honey, or a "pepper pilsner," produced jointly with another brewery, Himburgs Braukunstkeller. Black and pink pepper berries impart the taste of grapefruit, mango and bergamot to it. Or a "Welde

No1 Slow Beer Pils," a pilsner aged at least six weeks. Welde has been certified as a Slow Brewery by the Slow Brewing Institute. "Slow brewing requires the highest quality standards in everything from purchasing raw materials to brewing, all the way to managing the company," Spielmann said. "We see this as a good fit for us. After all, we have been brewing with craft methods from 1752 down to the present and can intervene in the brewing process at any point." ©

FOUR QUESTIONS FOR MAX SPIELMANN

WHAT IS YOUR FAVORITE DRINK?

Max Spielmann: I am a classic after-work beer drinker, during my personal downtime, when I sit back and reward myself with a brief period of relaxation. The beer has to be good. I enjoy our Welde No1 Slow Beer Pils because its yeast has had more time to ferment and its wort ferments more delicately. This gives the beer a very balanced taste profile and very refined flavors. Since I spend the entire day with beer in my work, I sometimes enjoy a glass of wine in the evening. Otherwise I drink mineral water almost exclusively – the carbonated kind.

WHAT IS THE MOST SIGNIFICANT DIFFERENCE IN TASTE BETWEEN CONVENTIONAL BEERS AND CRAFT BEERS?

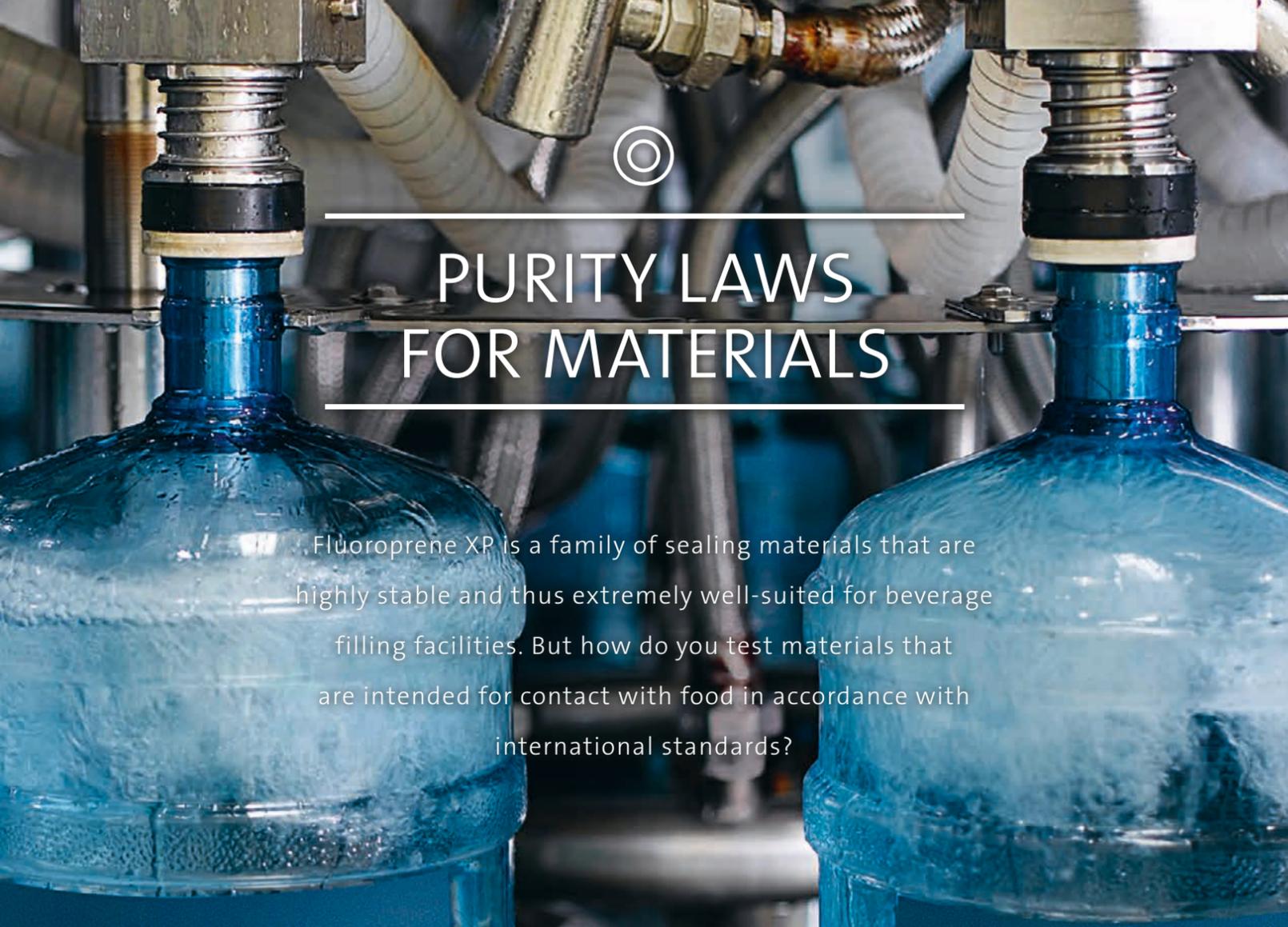
Spielmann: It is hard to define a general difference in taste. I would put it this way: with craft beers, brewers have always probed certain limits and pushed the extremes of taste. So there are very sweet and very bitter craft beers. But the craft brewer who intends to be successful long-term must achieve a balance between drinkability and unique flavors.

WHAT ARE THE SPECIAL REQUIREMENTS IN THE PRODUCTION OF HIGH-VALUE BEERS?

Spielmann: Many more hop flavors are certainly produced when various types of hops in much greater quantities and over a longer timeframe go into beer production – but higher costs are the result as well. And if barley is grown with greater spacing between the ears, fewer fungal spores develop – but that costs money too. Depending on the harvest, quality is always fluctuating. The art of the master brewer is to always produce the same end-product from materials that, by their very nature, do not always have the same characteristics.

WHAT ARE THE WAYS THAT A MASTER BREWER CAN AFFECT THE CHARACTERISTICS OF A VARIETY OF BEER?

Spielmann: Water is one lever that a master brewer can use. We have our own deep well with outstanding water rising from a depth of 172 meters, whose mineral composition has a major impact on the process of leaching the bitter elements out of the hops. Another lever is the yeast, which plays an important role in the fermentation process. When the temperature is increased, the process is accelerated. You can also affect activity with the pH level; here the master brewer employs the lactic acid bacteria on the malt. As part of the main fermentation process, he can also aerate the wort with oxygen before it is blended with the yeast in the fermentation tank. He can also work with air pressure: the greater the pressure on the yeast, the lower the activity. ©



PURITY LAWS FOR MATERIALS

Fluoroprene XP is a family of sealing materials that are highly stable and thus extremely well-suited for beverage filling facilities. But how do you test materials that are intended for contact with food in accordance with international standards?

Adults should drink between 1.5 and 2 liters of water a day, according to nutrition experts. If you are intent on following their advice and reach for a bottle of mineral water, you might prefer the water to be chilled, and health-conscious folks might keep an eye on the water's mineral or sodium content. But the most important aspect for consumers is so self-evident they don't even think about it – the water in the bottle must not be contaminated with impurities. This is not something they expect to deal with. Industrial drink processors and producers go to great lengths to ensure the purity of their beverages, whether they are fruit juices, varieties

of mineral water, milk, beer or wine. Extremely stringent hygienic requirements apply to filling systems and all their components, all the way from tube lines and connectors to seals – all the elements that come into contact with the beverage.

CONFORMING TO THE STANDARD

The seals, in particular, have an important task: they make sure that no dirt penetrates the filling operation and no fluids leak from the tubing system. The

material mixtures used in the seals inside these systems are especially geared to particular applications. They come from Freudenberg Sealing Technologies labs and have names like “75 Fluoroprene XP 41,” to cite one example. Their very names sound complicated, as does the information on the materials' product sheets. They contain whole strings of words, letters and numbers such as “FDA 21 CFR 177.2600” and “3-A Sanitary Standards Class I” or perhaps one of another three cryptic abbreviations. They refer to international standards and certificates. Freudenberg develops and produces materials in accordance with the requirements that they define.

It all begins with an idea that a material developer comes up with. For example, the material can be made more temperature-resistant if a bit more of a certain filler is added and if a bit less softener is used. Completely new materials can be part of the creative process for developing a recipe. Even if they harmonize well with the basic polymers and the compound and give the mixture even greater stability, developers still need to examine the so-called positive list.

POSITIVELY LISTED

Here they can find the raw materials that they are allowed to use. If an unlisted raw material is part of the recipe, it cannot not be used during the testing. The material developer has to make sure that all the polymers, fillers, cross-linking aids, softeners and processing agents are on the right list – no easy task since there is no single harmonized and valid list in use worldwide. Every country has its own approval process. The list based on American FDA standards, a yardstick for all elastomers in

continual contact with food, contains materials that differ from those in the European Union standards. Completing this work and finding the right mixture are important accomplishments. They are followed by migration testing.

Migration testing can be compared to an endurance run. Stamina is the order of the day. The tests often take at least six weeks of lab time. In a migration test, the substance, that is, the vulcanized material, is tested in media containing alcohol, water, fats and acids. At the same time, it is exposed to extreme conditions over various lengths of time and at different temperatures. During these “stress tests in lab beakers,” it must neither swell too much nor lose certain characteristics. An outside expert often checks the measured values all over again. The values of all the Fluoroprene materials lie within the tolerances defined by EU countries, clearing the way for their use in beverage filling facilities in Europe. Migration testing for the FDA and the 3-A Sanitary standard is also conducted to qualify materials for the U.S. market. But why conduct these protracted migration tests in the first place?

WHAT LIES BEHIND IT

Only highly resistant elastomers are capable of surviving the cleaning processes that are commonly used in automated filling systems today. Hot water, lye and acids are pumped through the tubing and other lines, usually followed by steam sterilization and perhaps the use of chemical cleaning agents. And there is another issue: these cleaning processes vary from one medium to the next. If beer flows through the system, the tubing system is usually cleaned with a 3 percent acid solution at 80°C (176°F) to remove salt deposits. If it's milk, chlorine cleaners are frequently used in addition to steam sterilization. But the beverages themselves also put the materials' robustness to the test, so migration testing covers a very broad spectrum of substances. If a compound passes these tests, it is a top athlete from a material standpoint, and only the champions are allowed to come into contact with food. ©

CHALLENGE

Beer, milk or lemonade – each beverage has its own requirements for the seals of bottling lines.





IT TAKES MORE THAN MILK

The creativity of today's dairies knows no bounds. Around the world, aseptic filling systems from the equipment manufacturer KHS make sure that only hygienically pure products reach the consumer.

At some point on a long road trip, things come to a head. The car is getting low on fuel, the driver needs caffeine and the twins in back need something to occupy them. In the service area, the refrigerated display case beckons. The kids want chocolate milk, the passenger in front settles on a healthy yogurt drink, and the driver buys a cold cappuccino. Back in the car, one of the children asks: "Daddy, did you put the chocolate milk in the bottles?" Thomas Niehr has to laugh. "No, sweetie, machines do that. My company builds the machines."

That company is KHS, part of the Salzgitter Group. A century and a half ago in Dortmund, Louis Holstein and Carl Kappert built the first equipment that could fill bottles up with beer – a form of the beverage that was just catching on. Today Niehr

heads the KHS product center, which focuses on aseptic filling technology. His area handles all the filling equipment that the company builds to bottle perishable drinks, including juices, smoothies and sport drinks, in addition to milk beverages. The products are subject to extremely high standards for germ-free filling. "Our core know-how is constructing these facilities to be extremely safe on one hand and highly efficient on the other," Niehr said.

He is in the perfect position to explain how chocolate milk gets into the bottle. It may be a surprise to laypersons, but the process begins with the manufacture of the bottle, at least if it is made from PET. This plastic is not only suited for beverages due to its high resistance to breakage – it can also be given any form or color that is desired. It is a good

REACHING FOR THE REFRIGERATED SHELF:
This chocolate milk was also bottled to the highest hygiene standards.





MAXIMUM EFFICIENCY:

In order to avoid long transport distances, the required PET bottles are produced directly on site and transported to filling lines.

choice for dairy products whose flavor could be altered by sunlight's ultraviolet range. "White PET bottles work especially well for milk products," Niehr said. "The trend is clearly moving in PET's direction at the moment." To avoid delivering the new bottles over long distances, they are produced right on the spot. It is becoming more and more common for the bottle-blowing machines to be connected to filling facilities.

The starting product is a PET blank (or more properly, a "preform") about the size of a bicycle grip. In a stretch-blowing machine – which comes from the KHS facility in Hamburg – it is transformed into a bottle. The blank is first heated to make it fluid, and then inserted into a mold (the "tool"). Air flows through its opening at a high pressure, pressing the plastic to the side walls of the mold. At the same time, a horizontal bar pulls the bottle lengthwise. The width of the bottle wall is just a few tenths of a millimeter – the exact thickness depends on degree of rigidity desired. KHS's patented Plasmax coating process offers extra protection. It applies an ultra-thin, invisible glass layer to the inside surface of the PET bottle, to keep flavors and carbon dioxide from escaping and to prevent the intrusion of oxygen

and the associated loss of vitamins. The flavor and the freshness are maintained in a bottle coated with the Plasmax process, just as they would be preserved in a glass bottle. This significantly extends beverages' retail shelf life.

HIGH-PRECISION FILLING VALVES

The filling of their products takes place in the heart of the facility, completely isolated from ambient air. The bottles either move in a carousel or line up below the filling valve, through which the precious content flows. The trick: although the entire filling process only takes a few seconds, the beverage cannot be permitted to foam up. The filling valve has several channels that are optimized to the direction and speed of flow. The challenge for Niehr and his team is that dairies are increasingly mixing bits of fruit into their drinks. As long as the length of their edges is under 3 millimeters, they can simply float along with the fluid. "But we are monitoring a trend toward larger and larger pieces of fruit," Niehr said. In some cases, a popular Eastern European drink known as kefir has fruit pieces a full centimeter long. KHS has developed a dosing unit

for these beverages that convey solid components into the bottles before the liquid portions follow them.

To assure beverage purity, the filling mechanism must not come into contact with the bottle's opening. The idea is to keep any food residue out of the area beneath the closure, which can consist of a tear-off foil, a screw top or a combination of the two. In the next step – which the fully automatic equipment handles – a bottle cap is affixed after it is disinfected with hydrogen peroxide. Then there is an inspection to guarantee the impermeability that is crucial for a long shelf life. Here a slight pressure is applied to the body of the bottle while monitoring the filling level. After another optical check by a 3D camera, a label is attached and the bottle is placed in a packaging case.

160 HOURS OF CONTINUOUS OPERATION

The KHS equipment, which is often used for decades, has to last far longer than the popularity of dairy products with the latest trendy flavors. "The diversity of dairy products continues to grow," Niehr said. Thanks to a completely modular construction that allows later expansion, the systems are prepared for a wide range of beverages. Any product can be produced on any dairy filling system. The growing assortment of products in refrigerated display cases is leading to another challenge. To be as efficient as possible, the facilities must operate over a longer interval before they require cleaning. A filling facility today runs for up to 160 hours without a break. Over this timeframe, a wide range of products go through the filling operation, interrupted only by brief periods of flushing with sterile water. One requirement is crucial: as far as possible, each section of the equipment must have high-performance components, such as seals, that do not absorb or give off flavors. To maximize productivity, wear parts – especially in the filling valve areas – are being replaced at fixed intervals. This allows the operator to schedule maintenance, which always involves an interruption in production. In the future, with the continuous monitoring of the equipment, it will be possible to schedule maintenance intervals more flexibly. Even the best technology reaches its limits if it is continually exposed to severe stresses. Strawberries are one example: their tiny but fairly hard seeds put components to the test. That may be a surprise to most people, but it is obvious to Niehr – who has been taking it into account for quite a while. ©

CAPPING IT:

The cap is screwed onto the bottle fully automatically after being disinfected with hydrogen peroxide.





FERTILIZERS À LA CARTE

Caring for each individual plant saves not only fertilizers, pesticides and water, but also increases a farmer's yield.

What sounds like a lot of manual work can be achieved with highly automated precision farming.



ROW BY ROW:
Combine harvesters with automatic steering systems keep to their paths with extreme precision.

More yield with fewer pesticides. For a long time, this was an inextricable conflict of interests. Those who switched to organic farming had to count on smaller harvests. The digitalization of agriculture has now changed that. It has always been the case that the better a farmer knows his land, the better he can farm it. That is why fields covering several hundred hectares are often divided into smaller sub-areas with technical support, the farmer then working them as individually as possible. Success always hinges on a farmer's knowledge of what to do when, where and with what machine. "Precision in modern agriculture is essentially influenced by two factors," says Dr. Joachim Stiegemann of CLAAS E-Systems, the digital subsidiary of the agricultural machinery producer CLAAS. "On the one hand, GPS-based technologies enable farmers to control their machines more precisely, and on the other hand, they can refine their knowledge of cultivated areas with georeferenced data."

AUTONOMOUS ATTACHMENTS

The technical solutions developed are as diverse as a farmer's tasks. CLAAS has been developing highly automated, self-propelled harvesting machines for many years. It recently developed an automatic steering system for driving precisely defined paths. The work program was spearheaded beforehand by the office's resident farmer. "Depending on which GPS technology and sensors are used, agricultural machines can be controlled with precision to two or three centimeters on the field," reports Stiegemann. Not only tractors, but even attachments are now highly automated. One example is a chipper used for mechanical weed control on corn, soybeans and sugar beet fields. Farmers have to be particularly careful not to damage crops while weeding. CLAAS E-Systems

has developed a system that makes it possible to guide mechanical weeding systems with an accuracy of a few centimeters between crop rows. "We use a special camera," explains Stiegemann. The system recognizes crop rows based on acquired image data and the software converts the camera images into control signals that are sent to the chipper's hydraulic control system. Chopping tools are guided along the crop rows with great precision without causing any damaging.

In digital farming, sensors also provide data with which machines can automatically adapt their working speed to changing field conditions. For example, a sensor measures the water content of the soil during sowing and reports to a software program. The program then adjusts the rotary disc applying the seed to rotate slower or faster depending on the data. Or a sensor on a tractor measures the amount of biomass at a

respective point when fertilizing in order to apply more or less fertilizer to the field. "With the connectivity of cultivation machines, more and more data on soils and plants is being collected to cultivate fields more efficiently while conserving natural resources," confirms Thomas Muhr, Managing Director of Geo-Konzept.

DATA HARVESTING

The Upper Bavarian company, which the agricultural engineer founded more than 25 years ago, sells sensors, GPS technology and agricultural software for crop planning to consultants and farmers. "Around ten to 20 percent of farms in Northern and Western Europe are now using precision agriculture tools," estimates Muhr. "And they benefit twice over." Muhr cites a wheat field as an example, where the soil at certain points cannot absorb enough water. If

the farmer is not aware, he would spread too much fertilizer. The soil would not be able to absorb the nitrogen fertilizer at those points, however, so the rain would shift it to other places or wash it out into the river system. Precise knowledge of soil conditions can avoid this environmental impact while saving fertilizer. Farmers are then also able to use additional fertilizer and increase their yields on soils that absorb more water.

Geo-Konzept software records data on soil factors in a so-called application map, which farmers can see on a large display in their tractors. The map includes not only the data collected by the sensors of the implements, but also historical data on the cultivated area and information from soil samples taken manually and analyzed in the laboratory. "Drones equipped with cameras and flown over fields are also being used more and more frequently," reports Muhr. "The analysis of the camera images

makes it possible to precisely determine the type and quality of the soil for a particular plot." This data is combined in the cloud, evaluated by software and then fed back into application maps. "Using application maps enables a farmer in traditional wheat, corn, potato or beet farming to reduce operating resource costs by up to ten percent," Muhr calculates.

"And even with less savings, you would at least use natural resources more efficiently and increase your harvest." It seems that digitalization is breaking with an old proverb: fortune may have favored the fool in the past, but in the future it will favor the well-connected. ©



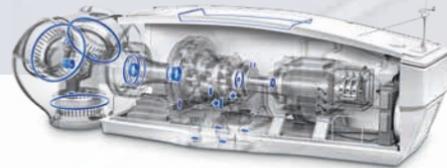
WEBINAR: MATERIALS AND TEST PROCESSES

A seal may fulfill a specification for a product, but that is a far cry from guaranteeing that it will actually function. Today food and beverage systems have to be reliably sealed to prevent leaks, malfunctions and the intrusion of impurities. In a webinar, Freudenberg explains what really matters.

A seal is only one element among many, but it is crucial for meeting the demands of the food and beverage industry. One current trend is the shift toward flavored mineral water, teas, energy drinks and coffee. It is making the business tougher for makers of beverage-dispensing machines since they have to offer countless syrup and drink combinations. Flavor transfer, the use of different cleaning solutions and leakage are all challenges to the industry. Innovative materials and robust testing processes are the answer.

Most seal suppliers have only a limited ability to test products, and most equipment manufacturers know little about elastomers. The two fields have to come together to develop solutions that actually work. The experts at Freudenberg Sealing Technologies are valuable guides to the development, testing and installation of the right products.

Several factors give them an advantage: an in-depth knowledge of different types of elastomers, the ability to develop the appropriate rubber compounds, and access to a range of demanding test procedures in-house. The company has many globally certified seal materials and state-of-the-art test procedures at its disposal. In a webinar, Freudenberg explains how to choose the right sealing material. ©



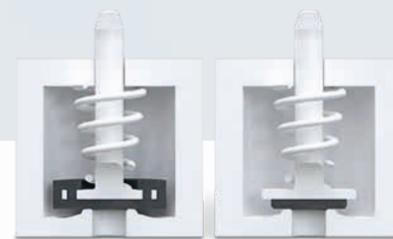
WIND ENERGY SOLUTIONS

Hydraulic applications in the wind energy sector have to meet increasingly stringent standards, such as a long service life, leak-free operation and reduced friction. Freudenberg Sealing Technologies' many accumulators and hydraulic seals are up to the task.

Wind turbines use piston accumulators to retain the energy they need to adjust their massive rotor blades. The accumulators are especially needed for the tilt adjusters at the center of the rotor. Hydraulic braking systems for use in emergencies are also found in more and more of these installations. Accumulators store the energy needed for fast braking and dispense it when it is needed. With the acquisition of the American manufacturer Tobul Accumulator in 2014, Freudenberg Sealing Technologies' global portfolio now includes a wide selection of piston, diaphragm and bladder accumulators in a range of volumes and operating pressures.

Working with its customers, Freudenberg Sealing Technologies is further developing its line of hydraulic accumulators. An overall view of the technology is crucial. The total cost of ownership is the key factor in the selection of system components for wind turbines. Freudenberg Sealing Technologies looks at the total cost over the entire life of the installation. Thanks to innovative designs, the customer needs fewer components and the system becomes less costly.

Furthermore, the operational reliability of the design guarantees more widely spaced maintenance intervals and a longer service life. Maintenance expenditures and the risk of malfunctions are reduced. ©



A STRONG CONNECTION

SCR catalytic converters reduce the nitrogen oxide emissions generated by diesels. A new adhesive technology from Freudenberg Sealing Technologies optimizes the precision and long-term stability of exhaust gas treatments and offers designers greater freedom in their work.

All new cars will have SCR catalytic converters in the future. In these converters, ammonia that is generated onboard reacts with nitrogen oxides, producing water and nitrogen, which is not toxic. An aqueous urea solution known as AdBlue is injected from an auxiliary tank in front of the catalytic converter to produce the ammonia. A precision dosing unit guarantees that the quantity of the urea solution only reaches the point that it produces the right amount of ammonia – no more, no less.

For dosing precision over the long-term, several providers of SCR systems use long-lasting, durable products from Freudenberg Sealing Technologies to seal components reliably. It is crucial to keep the edges of the contact surfaces between the seal and the carrier body for the components from coming into contact with AdBlue. The urea solution would attack the connection and detach the seal.

Freudenberg Sealing Technologies has developed an adhesive technology that is extremely resistant to the urea solution. Tests on material samples showed that the bond remains totally intact after a weeklong immersion in AdBlue at 85° C. A coating permits a reduction in the weight of switching components. The lighter the components, the more precisely and rapidly they can be switched – and the more exact the AdBlue dosage. ©



LIGHTWEIGHT DESIGN FOR GREATER EFFICIENCY

Hydraulic accumulators make transmissions with hydraulic systems more energy-efficient. Freudenberg Sealing Technologies has now developed a lightweight plastic piston for accumulators. The sealing system consists of a single component and is easier to install.

Hydraulic accumulators employing a piston separator are used in dual clutch transmissions for internal combustion engines and hybrid drives. They make it possible to reduce the size of hydraulic pumps and the electric motors – thanks to the interplay of hydraulic fluid on one side of the accumulator and gaseous nitrogen on the other.

Now Freudenberg Sealing Technologies has developed a plastic piston for hydraulic accumulators that is significantly lighter and easier to install. It replaces a steel piston that incorporated a sealing package made of four components. The plastic piston, which is produced with an injection molding process, only requires the installation of a single sealing ring. The selection of the right piston material with the required slide and thermal characteristics proved to be crucial in the innovation's development.

The technology demonstrated the necessary maturity in wide-ranging test stand trials and road tests. The piston, made of a thermoset plastic, has withstood several million switching cycles. The special geometry of its seal guarantees a long operating life. Working with a German premium automaker, Freudenberg Sealing Technologies is developing a hydraulic accumulator with a plastic piston to series production readiness. They are intended for a hybrid vehicle. ©



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EDITORIAL

Profilwerkstatt GmbH,
Redaktionsbüro delta eta

DESIGN & CONCEPTION

Profilwerkstatt GmbH

PRINTING

ABT Print und Medien GmbH
Bruchsaler Straße 5
D-69469 Weinheim

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