VAHTERUS

LNG in Spotlight

The Future Is Bright on Land and on Sea

Research & Development: Plate & Shell Heat Exchangers in Cryogenic Applications

HOT&COLD

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ON THE COVER

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Testing Vahterus heat exchangers using liquid nitrogen at a temperature of -180°C.

Back:
Details of nitrogen-test equipment.

Photography:
Anton Sucksdorff except pages 28–38 images courtesy of clients

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Development Continues Despite Difficult Times

None of us could have guessed how radically the world would have changed since we published the last issue of our magazine. Most countries are in lockdown and all public gatherings and events are banned. Travel is restricted by special legislation. And all of this because of a sudden and tragic virus pandemic that changed the way we live and work in the space of just a few weeks.

Luckily, in the heat-transfer business, investments continue to be made. Our customers are always striving for ways to make energy savings and to find circular solutions, and it's our ambition to remain in partnership with you, our valued clients, in researching this development work. Together, we can improve our processes and discover sustainable solutions to tackle climate change and ensure a safe environment for the next generations. We thank you for your continued inquiries and orders. What's most positive is that our factories are operating at full capacity and there are no signs of the coronavirus in any of our companies globally.

LNG opens doors

In this edition of *Hot & Cold*, we focus on heat-exchanger solutions in LNG applications. Our customers are changing energy source from heavy fuel oil to Liquefied Natural Gas (LNG), which is becoming an increasingly popular fuel in marine and onshore applications and in power generation.

The rich possibilities offered by LNG have encouraged us to undertake extensive R&D work to understand the special features of heat transfer with cryogenic fluids. For an engineer, it's always exciting to see the extremes, for example in temperatures, like using liquid nitrogen at temperatures of -180°C to test our heat exchangers in an environment that's equal to LNG vaporising conditions. That's pretty cold!

In these conditions, the materials, the welding quality, as well as heat-transfer efficiency of our exchangers are rigorously tested. That has been our focus this spring. On the following pages, you can read about a larger series of cryogenic experiments in our Test Lab and about FEM simulations that help us to continuously improve the constructions used in the cryogenic environment. We've also successfully refined our processes. The development research is done together with you, our customers, and the work continues. I believe that the use of LNG will increase significantly over the next decades, especially with large engines. We at Vahterus are making it our business to be part of this development work in the future.

Reasons to celebrate

Vahterus was founded on 5 September 1990 and we're approaching our 30th anniversary. Unfortunately, in the circumstances it looks as if we'll have to postpone our celebrations of this landmark event with you. It also seems we won't be gathering at exhibitions this autumn, because most events have been cancelled.

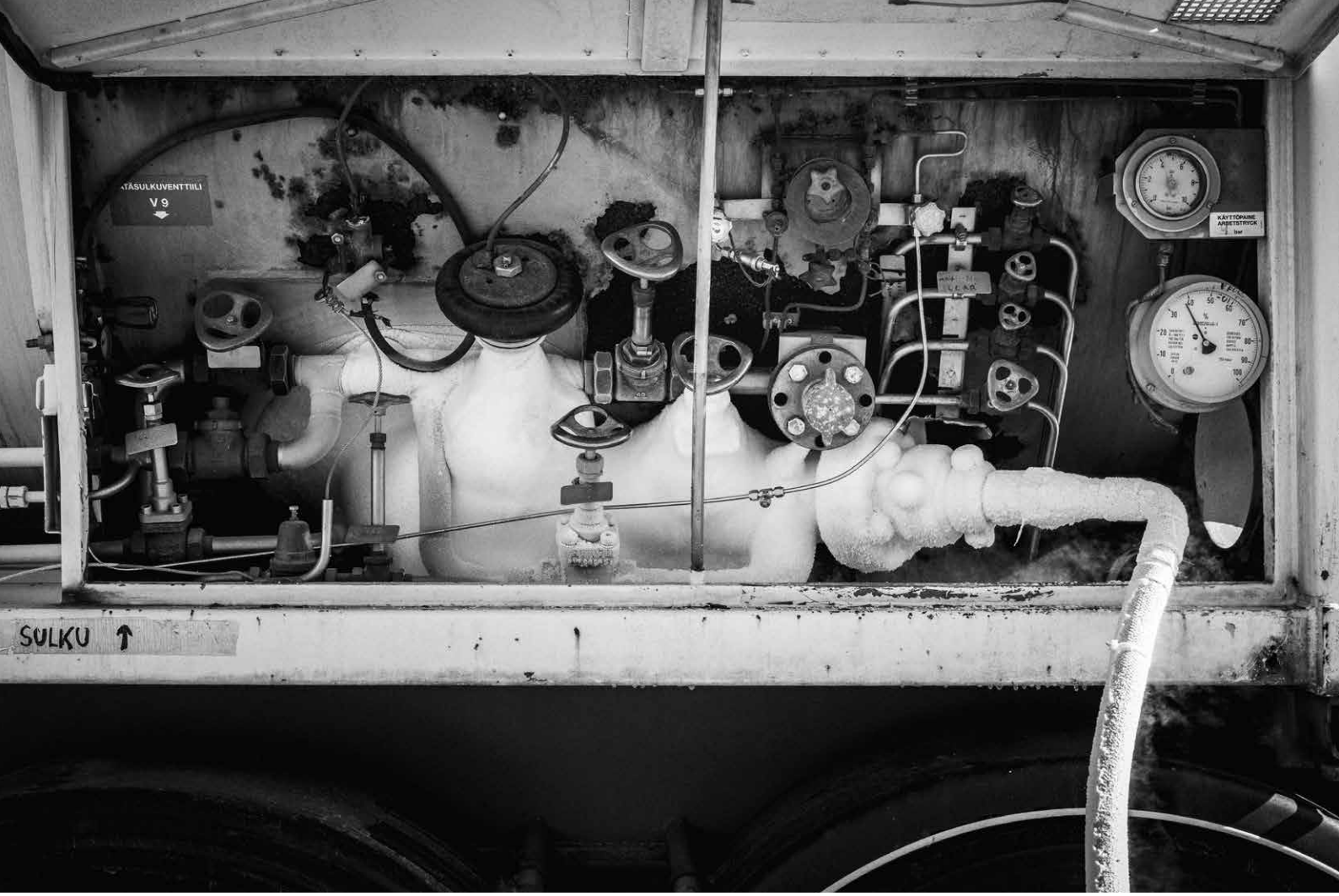
However, we look forward to getting together with you when the pandemic passes. In the meantime, we'll do our best to stay in touch on other platforms digitally.

I wish you health and continued success in your business!

Together we succeed!

Mauri Kontu
Founder and CEO

Founders Mauri and Sinikka Kontu photographed in the village of Vahterus.



Vahterus is currently conducting a large series of tests to understand the special features related to cryogenic applications.

Research & Development

Vahterus Test Lab Was the Coldest Spot This Winter

Valtteri Haavisto, Customer Service Director at Vahterus

Vahterus is currently undertaking an interesting series of tests. Previously, we have focused on high temperatures, phase-changing phenomena and fluid hydraulics. This time, Vahterus test lab personnel are conducting a larger series of cryogenic tests. Using liquid nitrogen at temperatures of -180°C, it is possible to test our heat exchangers in an environment that is equal to or even more challenging than normal Liquefied Natural Gas (LNG) vaporising conditions.

We've undertaken extensive R&D work to further understand the special features related to cryogenic applications, and the aim of this large test series is to further

understand the special features of heat transfer with cryogenic fluids. We've invented several unique solutions that allow operations closer to freezing point, and extend the unit's lifespan in this demanding operating environment. As always, such development work requires both theoretical understanding and practical testing in a real-scale set-up.

The tests conducted so far strongly indicate that the new products and new solutions will meet the targets set. The most important finding has been the excellent thermal cycling resistance of Vahterus Plate & Shell Heat Exchanger.

Demand for cold recovery in LNG applications is pushing systems to provide increasingly low brine temperatures. We investigated how to avoid brine freezing. One target was to identify when and how the glycol starts to freeze. Liquefied nitrogen was vaporised at about -180°C, and 50% ethylene glycol was used as a heating medium. We found that good heat-exchanger design makes it possible to use very low glycol outlet temperatures, avoiding the risk of freezing. Even the cold side inlet temperatures are less than the freezing point of glycol.

There are still plenty of tests to be done, but the start has been strong.

Vahterus FEM Simulations Rise to the Cryogenic Challenge

Kalle Vähätalo, R&D Engineer at Vahterus

Low temperatures and widely varying temperature differences in cryogenic applications can cause high stresses to the constructions. Practical testing of constructions is often complicated and time consuming, which is why modelling and simulation tools have become an important part of the development process. During the last couple of years, Vahterus has made many FEM (Finite Element Method) simulations of constructions used in cryogenic applications.

The FEM simulation process starts with the 3D modelling of the studied construction. The geometry is then divided into elements that constitute the calculation mesh. Boundary conditions and loads describe the external forces and surroundings of the structure. The differential equations representing the phenomena, such as stresses and displacements in the structure, are numerically solved. There are many methods for determining structure lifetime, which generally use the highest stresses in the structure, as determined by FEM simulations.

When modelling and simulation tools are used, it is very important to ensure that they are truly representative of the problem studied. Vahterus employs its comprehensive testing facilities to validate all models utilised in simulations.

Thermal stress is probably the most important factor determining the lifetime of the LNG evaporator. The temperature distribution inside the heat exchanger needs to be defined precisely when thermal stresses are simulated. CFD (Computational Fluid Dynamics) simulations can be used to determine the temperature distribution. From 2018–19, Vahterus collaborated with Tuomas Kyllönen of Elomatic on his Master's thesis, 'Computational Fluid Dynamics Analysis of a Pressure Build-Up Unit of a Liquefied Natural Gas Fuel System', where he studied the temperature distribution inside the Vahterus heat exchanger.

Using FEM simulations has helped Vahterus to continuously improve the constructions used in the challenging cryogenic environment.

It Runs in the Family

Founded by Mauri and Sinikka Kontu, Vahterus is proud to be a family business. The company also employs three members of the Ahola family.

Vahterus Editorial Team

Jukka Ahola has been with the company for the past two decades. His daughters **Anna Ahola** and **Elina Seikola** first came to Vahterus for summer jobs, Anna in 2006 and Elina two years later.

It was an open Facility Manager's position that brought Jukka to Vahterus in 2000. He currently works as a Maintenance Installer and team leader responsible for the construction and maintenance of Vahterus' production equipment. With growth as a strategy, a lot of new equipment is currently being built. Therefore, a significant part of his work hours are spent in the office.

'I work with the design team going through their drawings', Jukka says. 'There's a lot of paperwork involved in purchasing materials and sourcing subcontractors. I keep in touch with the companies we use for design and machining almost on a daily basis. The machines we build are usually assembled by our skilful inhouse team, and I try to be involved in the process as much as I can.'

Each family member expresses appreciation of the others' commitment, diligence and ability to solve problems. Jukka is happy about the success of his daughters and their well-managed careers. One trait that clearly unites the family is grit: the willingness to do the work required for achieving a goal.

'My father is a doer, with his mind full of ideas', Elina says. 'While others are still planning to do something, he's probably finished the job already. I can't think of a task that he hasn't accomplished. Even if we present him with an idea that seems challenging, he'll find a way to overcome the challenge and get things done.'

Elina works as a Project Manager in the Vahterus design team. She graduated Master of Science in Technology in 2013 with a major in Industrial Economics and a minor in Information Technology. As Project Manager, she is responsible for orders that require particular tailoring and are therefore designated as projects, ensuring that the customer receives the solution that meets their specific requirements within the agreed timeframe.

'A project manager is the link between the customer and Vahterus design and production teams, keeping everything tied together', Elina says. 'With tight schedules, the ability to solve problems and proceed quickly is essential. The challenge is that each project has its own special requirements and there are no standard answers to a question. However, by continuing to do the work, you learn new things every day and develop a valuable skillset.'

Anna applied for a summer job at Vahterus in 2006 and following the first summer she came back year after year, working as a Sales Coordinator. Having graduated Bachelor of Business Administration in International Business in 2013, she got a full-time job at Vahterus. A few years ago, she started studying engineering in production economics alongside work, and since April last year, she has worked as a Sales Engineer in the Refrigeration team.

Anna enjoys the dynamic nature of her work and the fact that every day is different. 'Variation brings meaning and allows you to challenge yourself', she says.

In a fast-changing world, efficiency is improving and sustainability is becoming increasingly important. This naturally affects the needs of Vahterus' customers.'We

Jukka Ahola has been with the company for the past two decades. His daughters Anna Ahola and Elina Seikola first came to Vahterus for summer jobs, Anna in 2006 and Elina two years later.

have to develop ourselves constantly to be able to respond to the changes in the market', Anna says.

Just like her sister, Anna praises her father's diligence and grit. 'I've learned from my father that in order to achieve something, you have to be willing to work for it. He's also taught us about reliability: if someone is counting on you to do something, make sure you do what was agreed on. I try to stick to these principles', she says.

Jukka, Anna and Elina work in different buildings, which means they're not constantly running into each other at work. And yet there is a sense a security that comes from knowing that you have your family close by and you have a family business as an employer.

Anna appreciates not only Vahterus' values per se, but also the way they are demonstrated in the culture of the company: people are encouraged to take care of themselves and everyone's point of view matters.

'Although Vahterus does business globally, the company's roots and locality are always emphasised', Elina says. '**Mauri** [**Kontu**] always underlines the role of family and health in overall well-being. These two can't be neglected if you wish to keep your work/life in balance.'

LNG Market Outlook – The Future Is Bright on Land and on Sea

Versatile and easy to transport, LNG is an increasingly popular fuel both in marine and onshore applications. Besides energy, LNG is used as a raw material in chemical processes, and its full potential is being unleashed through heat transfer and cold recovery.

Frans Launonen, Key Account Manager at Vahterus

In January 1959, over 60 years ago, the world's first LNG ocean cargo was shipped from Lake Charles, Louisiana, USA, to Canvey Island in England. The vessel herself, a 'methane pioneer', was retrofitted from cargo ship to 32,000 barrel LNG tanker (the equivalent of a 5,000 CBM LNG bunker vessel today). Its mission was to demonstrate to the world that LNG could be transported safe and sound – even over longer distances.

There are two key reasons why LNG is now being used globally: firstly, when changed from gas to liquid at ambient pressure, LNG takes up 600 times less storage space. Secondly, transportation is much easier, since the restrictions caused by pipeline infrastructure do not apply. The diversity offered by LNG is the reason why it has become a economically competitive alternative to traditional Natural Gas. It has brought heavy competition to historical pipeline gas suppliers and other alternative fuels while lowering the market prices. Technology investments are still significantly higher than so-called commodity fuels such as LFO, HFO and coal. However, times are changing rapidly and awareness of the impact on human health and the ecosystem of harmful GHG (greenhouse gas) emissions is increasing. Natural Gas is one step in the right direction, since it creates approximately 20–25% less CO_2 and roughly 85% less nitrogen oxide emissions in combustion in comparison to diesel. When compared to coal, LNG offers even greater benefits, with 40% less CO_2 emissions for equivalent power. At the same time, Natural Gas exhaust has literally zero particle matter and sulphur. LNG is playing a growing role in the transition to a lower-carbon energy system both onshore and offshore.

LNG is becoming an increasingly utilised fuel in the marine markets. Marine vessels were originally powered by wind and then steam. Next came the era of fuel oils LFO/HFO. We are now at a new tipping point towards a completely different means of power. Starting from this year, shipowners globally will be required to fulfil the sulphur gap requirements of max 0.5% sulphur content in fuel. In emission-controlled areas such as US coastal waters, the Baltic Sea and EU harbours, an even harsher limit of 0.1% must be met. There are two ways to tackle this: with a fuel that does not contain sulphur, or with a fuel that has sulphur but with an exhaust-gas treatment.

For HFO, exhaust-gas treatment is required, which involves Selective Catalytic Reduction (SCR) in combination with either open- or closed-loop scrubber solutions. Both have pros and cons. Open-loop solutions are banned by many harbours, which lowers their future market predictions. This makes the low-sulphur fuels – either Marine Diesel (MGO) or LNG – the most attractive solutions for

Thousands of new jobs will be created in this field. Universities are taking this into consideration in their courses and Vahterus has been an active partner in this development. We believe the reasons for our high market share are related to technological and application know-how and we continue to work closely with education to create future jobs. Enhanced cooperation with our partners and customers, now and in the future, is extremely important. If you're not ahead – you're behind.

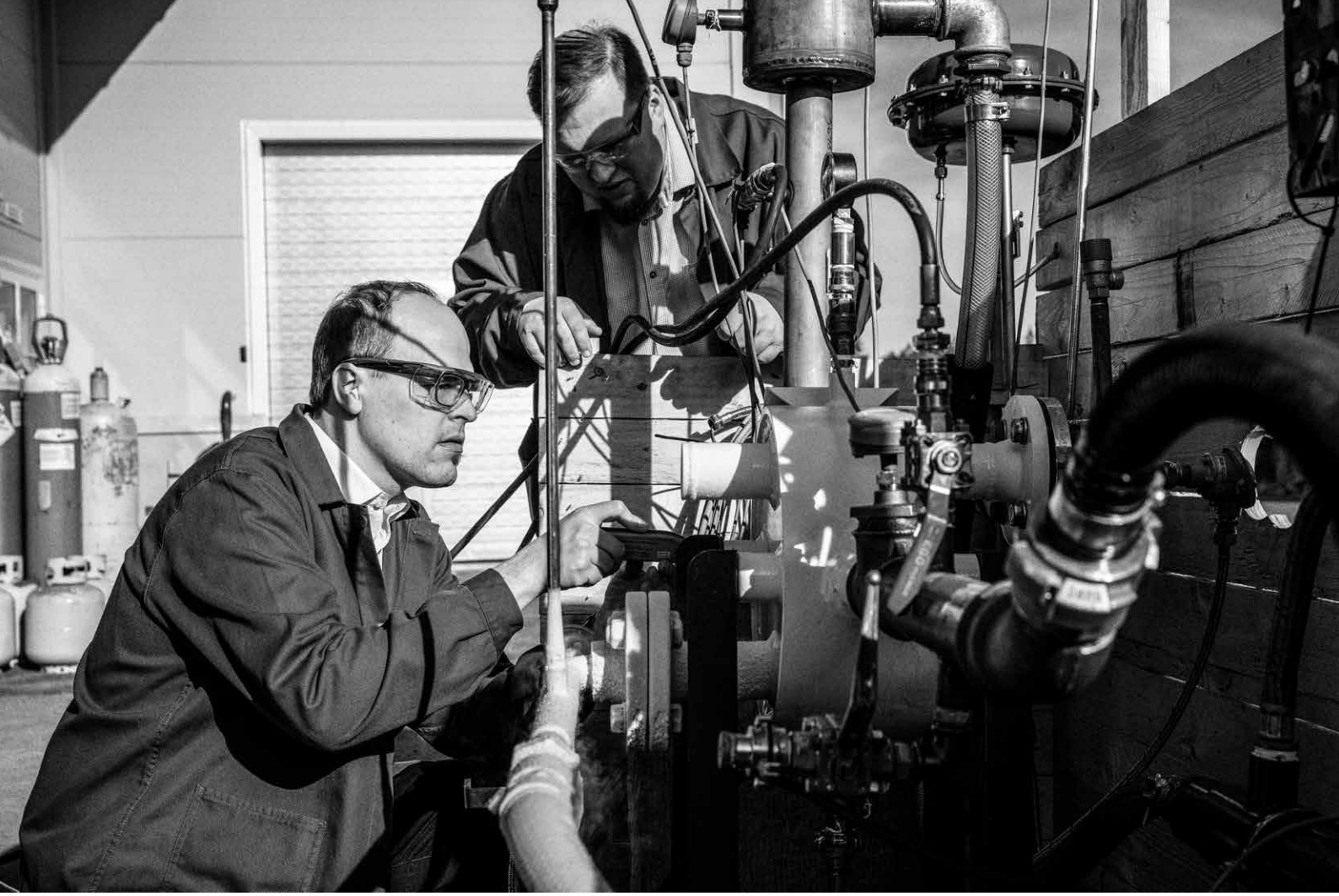
most ship-owners. Marine Diesel comes at a premium price, but only SCR is required in the process. With LNG, not even SCR is needed. Often, the engines on vessels are Dual Fuel (DF), capable of running either on LNG or marine oils. Such engines are more expensive, but the owner benefits from the flexibility of fuel sourcing. However, in terms of storage and fuel-gas handling, there are downsides to LNG. LNG/NG has more energy per kilogram than diesel/MGO. This a benefit when you burn the gas, since you need less fuel mass to produce the same power. However, LNG requires close to half more storage space than diesel. Additionally, cryogenic solutions require more expensive materials, such as stainless steel, and entail certain safety issues. In the future, there will be vessels featuring novel technologies such as hybrids and battery-driven propulsion. Currently, battery-driven vessels are limited to short routes with predictable operation, since charging in harbours takes time. Hybrid vessels are likely to be used on longer routes in the near future.

Safety has been a priority since the very first ocean LNG cargo was transported in 1959. It is thoroughly addressed in the International Maritime Organization's (IMO) design guidelines 'IGF code' for gas-fuelled vessels, which came into force in January 2017, along with Marine Classification Society guidelines. Even though the public see LNG as hazardous, it only burns in certain limited conditions. If there is roughly less than 4% Natural Gas in the atmosphere, it is too lean to burn, and if there is more than 17%, it is too rich to burn, making it a safer option.

After the imposition of the 2020 sulphur-gap requirements, it is likely that for a short period MGO will take most of the markets since it is so easy to use with no changes to current vessels, but due to MGO's premium price, LNG is forecast to be the winner in the long run. For example, DNV GL, a globally well-known classification society, is forecasting LNG to become the leading fuel solution within the next 20 years. This is a bold statement, considering that there are currently fewer than 200 LNG-fuelled vessels in operation in a global fleet of 50,000-plus vessels. However, during this year there will be roughly 40% more LNG-fuelled vessels on the market.

Vahterus has been developing the gas vaporisation and heating technologies required. Our market share for heat exchangers on LNG-fuelled vessels is over 50% and our current high activity with our customers supports the future growth expectations. Marine LNG solutions will be utilised for all size classes and in different kinds of applications, from small LNG-powered tugs to the world's largest cruise vessels. In the future, efficiency and emission reductions will be even higher. IMO has a target to cut down GHG emissions by at least 50% by 2050 compared to 2008. This is an ambitious but reachable target, despite the fact that marine traffic will grow at the same time. LNG will have a strong role here.

While there is much discussion of the use of LNG in marine markets, it is mainly used in onshore markets. Earth's growing population and living standards will require more energy in the coming decades. The global population grew by 700 million during the last decade. That train is slowing down, but the United Nations is forecasting close to 1% annual population growth for the next decade. Currently, the biggest buzz is around renewable energy. There is a clear reason for this: renewables are becoming the cheapest option for consumers. This leads to the biggest new challenge, which is the storing of energy and handling the sudden peaks in demand when the sun does not shine or there is no wind. Natural Gas and LNG are favoured as an energy source in peak power generation because of their flexibility. Due to the fact that fewer and fewer power producers want to buy baseload power



This spring, Vahterus Test Lab has undertaken a larger series of cryogenic tests. Pictured here are LNG experts Frans Launonen (left) and Lauri Bastman (right).

generation and inflexible assets, large and inflexible units are being shut down. CO_2 intensive technologies are also being kicked out of the portfolio one by one. During 2019 alone, over 300 TWh of coal generation was eliminated, according to Shell LNG Outlook 2020. And this is just beginning, since by 2040 it is expected that nearly 70 GW of coal power generation will be cut (installed coal capacity is now nearly 2,100 GW). In 2019, the largest amount of global Natural Gas was consumed by power generation, which was followed by the residential and commercial sector, and then industry and transportation. By 2040, the largest growth will be in the power generation market in Asia.

Besides energy, LNG can be utilised in various ways as a raw material in some chemical processes. In both onshore and offshore markets, the next revolution will be tapping the full potential of LNG through heat transfer – the 'cold energy' recovered from the vaporisation process for air conditioning, freezing/galley systems and on a larger scale for district cooling networks. This will mean that net

efficiency in current and future LNG-driven solutions can be further increased by shutting down stand-by units or those running on low load in the system, such as refrigeration units. Development will not stop at this point; it will further concentrate on system levels, and the fruits of this process optimisation will be seen not only in OPEX but also as a CAPEX reduction due to more simplified processes.

LNG is not a one-size-fits-all solution. For years, the tendency has been towards bigger LNG terminals, but thanks to reductions in the cost of technology, LNG is becoming available to small-scale consumers. Such LNG facilities serving more modest demands usually have capacities of 30,000 cubic metres and lower. LNG is far from a commodity fuel, but every day it comes a step closer. Along with diversification to current Natural Gas markets, LNG can enable rapid solutions for current and new markets in the form of Floating Storage Regasification Units (FSRU). These floating vessels can be newbuild vessels or old LNG carriers retrofitted to FSRUs, which are then used to supply local consumers via Natural Gas pipelines. The building times of FSRUs are much faster and permit processes that are significantly easier if compared to land-based LNG terminals. The building of an FSRU can start in the shipyard without full permits. On a long-term operation basis, onshore LNG terminal have slightly lower usage costs, but with FSRU, you can sell the asset forward on the markets if LNG demand drops in the user location. This is a significant benefit that FSRU can offer over the traditional land-based LNG terminals.

Lithuania is a good example. In 2014, the country leased the FSRU called 'Independence' from Höegh LNG under a ten-year contract. This was one step towards more open Natural Gas markets in Europe and competition on gas pricing. Energy-wise, an FSRU can be compared to a small nuclear plant, which can feed not only flexible power generation but also baseload if required. For example, 'Independence' could feed with her 170,000 CBM a 1,000 MW combined heat and power plant, on stable load over one month on a 24/7 running basis. By loading the FSRU between ~1-month intervals, this same power could be generated constantly. Floating solutions enable tailored solutions, especially for remote locations such as islands, which are currently using traditional fuels like LFO, HFO or coal in their energy portfolio. In South East Asia only, a 600% growth demand is expected by 2040 according to Shell, and floating solutions are surely part of that expansion.

Even if LNG is considered the most environmentally friendly fossil fuel, it is still, at the end of the day, a fossil fuel. However, all current and future systems based on Natural Gas can be switched to run on whatever is the most environmentally friendly methane. The fact that LNG-fuelled systems can be run with biogas and synthetic gas makes them future-proofed. Many companies have already done testing and even switched to biogas. This is much more than a PR issue: it is a decision that makes one company more sustainable than others, and will affect customer buying decisions in the end.

The future of Natural Gas, and especially the LNG industry, is bright. People in the industry are no longer talking about the chicken and egg dilemma as they were five years ago. The opportunities provided by LNG are clearly recognised. Despite that, there is still room for innovation and progress. Thousands of new jobs will be created in this field in the future. Universities and schools of applied sciences are gradually taking this into consideration in their study selections. Vahterus has been in the frontline of this development, and we want to guarantee future workplaces together with study facilities. We believe the reasons for our high market share are related to technological and application know-how. Our close co-operation with our partners and customers now and in the future is extremely important. If you're not ahead – you're behind.

The future of natural gas, and especially the LNG industry, is bright. In both onshore and offshore markets, the next revolution will be tapping the full potential of LNG through heat transfer – the cold energy recovered from the vaporisation process and used for air conditioning, freezing systems and on a larger scale for district cooling networks.

The Path to Becoming LNG Experts

Vahterus' LNG journey began in 2005. Through extensive R&D work and with over 300 heat exchangers delivered to cryogenic LNG applications, we're now leaders in the field.

Lauri Bastman, Sales Engineer at Vahterus

Every expert was at one time a beginner; everyone starts the journey from the same position of inexperience. This is particularly true of those who are the forerunners of industry. There are no ready-made answers, there are no well-established procedures, and there are no decades of practical experience letting you know what works and what doesn't. That is, in the beginning.

For us at Vahterus, our journey with LNG properly began in 2005 with Boil-Off Gas heaters. Before that, we had of course worked with Natural Gas in various applications and temperatures, but now we were working close to the liquid tanks and at cryogenic temperatures. The second milestone came a few years later, when for the first time ever, we started working with Liquefied Natural Gas. The heat exchanger in question is still operating well to this day, using cold methane liquid to condense LNG back into a storage tank. The heat exchanger was not a very large one, as they are these days, with only 60 kW of duty, or about 450 kg/h of condensing LNG. But as a brave man once said, sometimes small steps can be giant leaps.

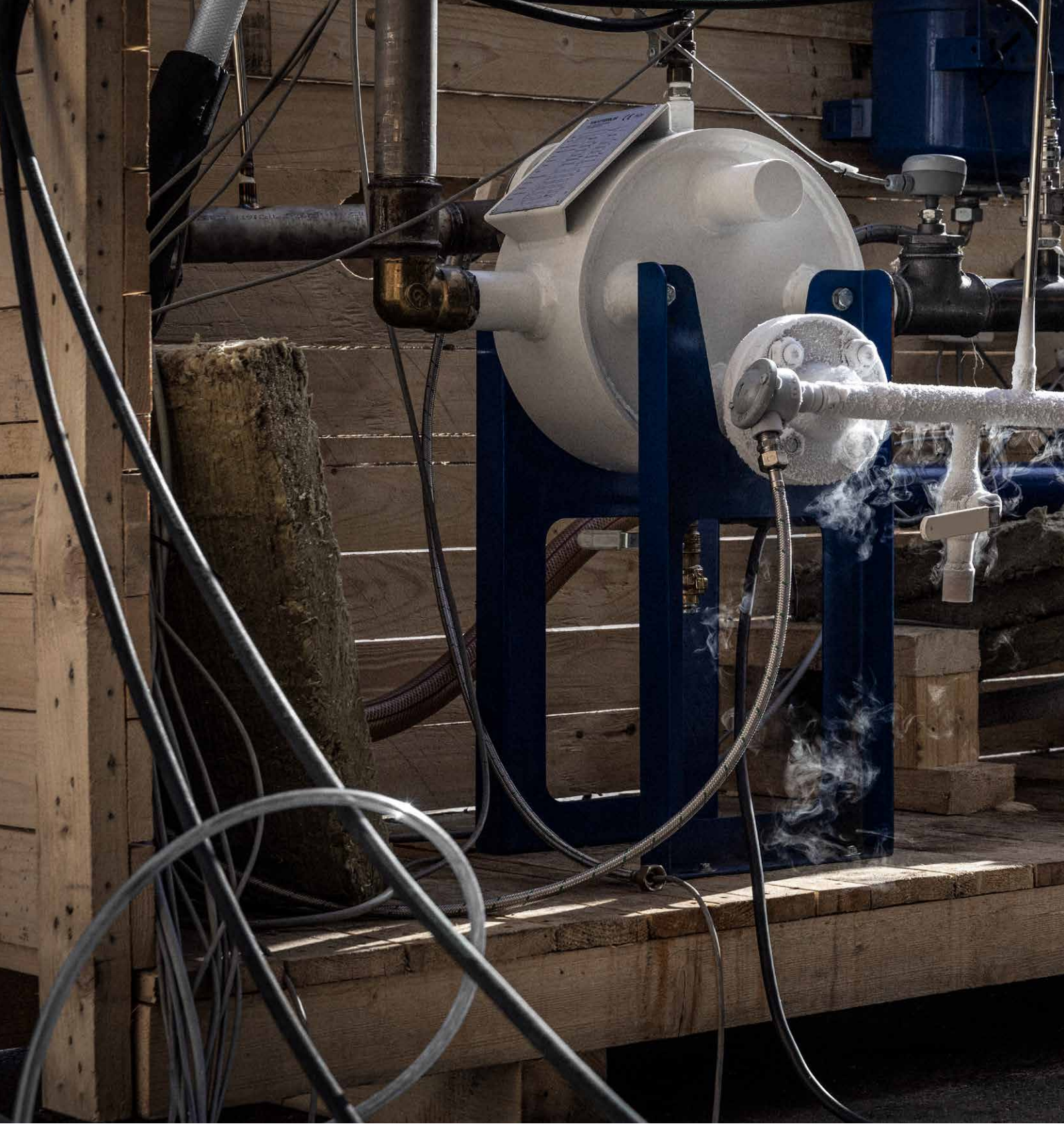
It was certainly that way for us at Vahterus. We proved in practice what we had known for a while: that the original Vahterus Plate & Shell can be adapted and made ideal for LNG applications. This was further proven just a short while later, when we took another step and entered the machinery spaces of LNG-powered vessels by supplying LNG fuel vaporisers under strict Marine Classification Society guidelines.

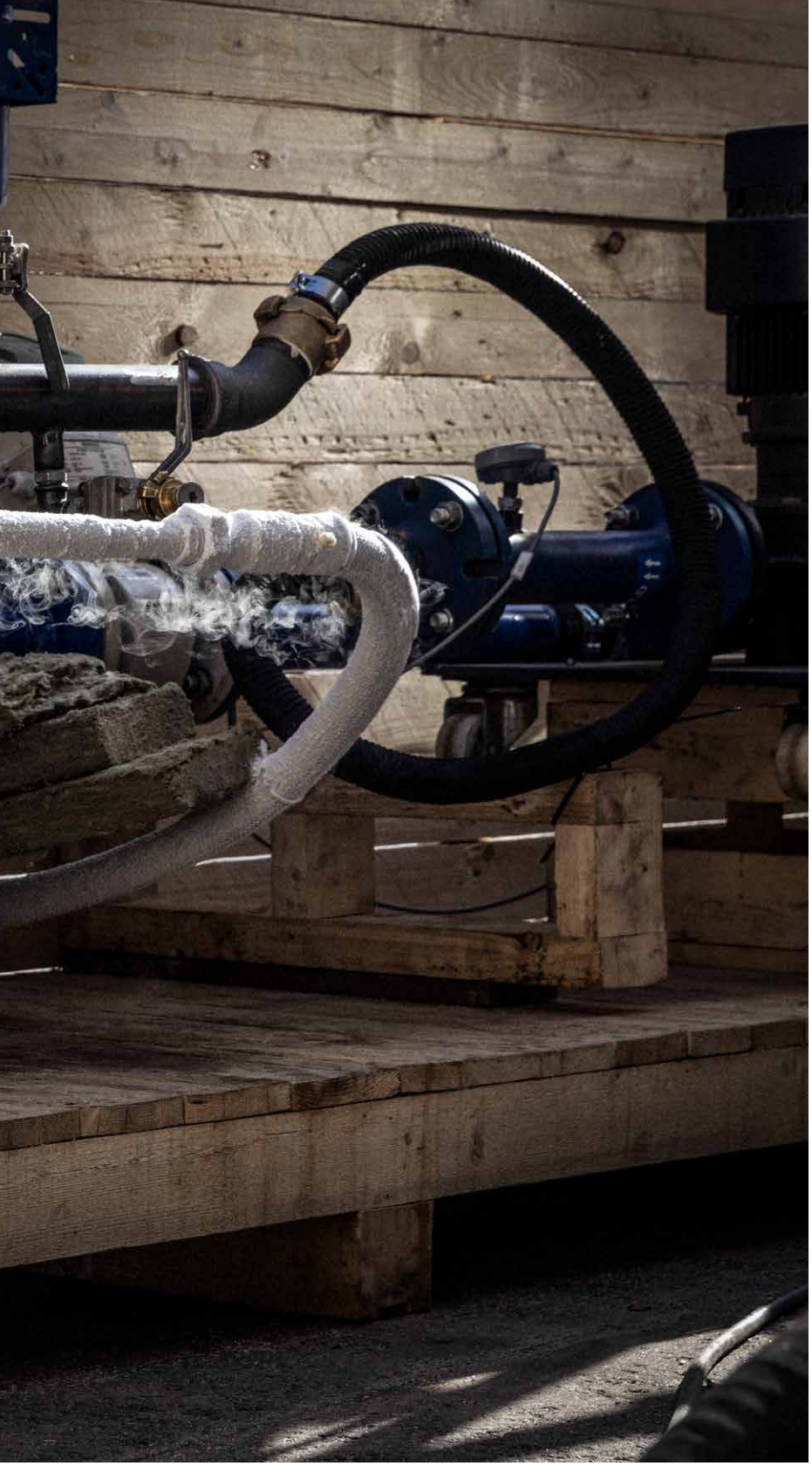
With our willingness to collaborate on developing tailored solutions, and the several benefits of our technology compared to the more traditional solutions, we were the obvious choice of manufacturer. There are numerous inherent benefits to our basic design, when compared with competing technologies such as Shell & Tube. One of the greatest of these is the small size. This minimises the use of materials to bring down costs, and reduces the footprint – anyone who has visited the machine spaces on a vessel will know that space is at a premium. Since the heat exchanger tends to be one of the largest singular components in an LNG skid, the small size of a PSHE allows for massive space savings.

Unlike a Shell &Tube heat exchanger, a Vahterus LNG vaporiser can vaporise and superheat the LNG inside the same unit, in many cases completely removing the need for a separate superheater. This brings further savings on cost and space, and grants far greater flexibility to skid- and piping-layout designers.

Doing something new is of course rarely plain sailing. There are challenges when working with cryogenic LNG, and we ourselves have met some of these over the years as we constantly strive to innovate.

While the round plate is highly resistant to thermal cycles, due to its small size a PSHE unit does not have a large charge or reserve of hot media, such as glycol-water, inside it. Consequently, a poorly designed Plate & Shell unit built without taking the system's special





Vahterus LNG vaporiser can vaporise and superheat the LNG inside the same unit, in many cases completely removing the need for a separate superheater. This brings further savings on cost and space, and grants far greater flexibility to skid and piping-layout designers.

An exciting new trend in LNG-related applications is the growing number of cold recovery systems. The idea behind cold recovery is simple: energy has already been applied to liquefy the LNG and store it in cryogenic conditions.

requirements into consideration can lead to freezing issues and non-functionality of the exchanger. With simulations and data from the field, we have identified the causes and mechanisms behind such potential dangers in our exchangers, and our tailor-made LNG heat exchangers implement several solutions to ensure the best possible functionality in all operating conditions. Our development work has constantly broken new ground and we have several patents pending for cryogenic heat exchange.

But the challenges go even deeper – to the very foundations of heat transfer. As the original inventors of the entire Plate & Shell technology, during the foundation of our company 30 years ago there were no ready-made methods of directly calculating heat-transfer coefficients or other necessary information for even the simplest applications. We adapted the well-established principles of general heat transfer and equations made for other technologies to our own needs based on testing and real-world experience. When we introduced LNG applications as possibilities for Plate & Shell, we had to adapt those equations again based on new data. Thanks to the efforts of our extensive R&D programme and years of data from operational heat exchangers, we have now developed our very own fine-tuned custom-built thermal design programme for LNG applications, allowing us to model their thermal behaviour, freezing potential and much more.

Yet work remains to be done. We fully intend to remain at the tip of the spear, leading the technology and market in onshore and marine LNG heat exchangers. This requires further development of brand-new ideas, refining, testing and improving technology, in order to provide the best possible solution to our customers. Our ongoing R&D programme plays a critical role in this, and we continue to invest heavily in it. This spring, we are launching large-scale active testing in our own laboratory for LNG

Our custom-built LNG heat exchangers implement several solutions to ensure the best possible functionality in all operating conditions. Our development work has constantly broken new ground and we have several patents pending for cryogenic heat transfer.

exchangers, with a dedicated customised testing rig for even more extreme conditions and greater capacities, using cryogenic liquid nitrogen to provide us with more data to supplement our small-scale liquefied nitrogen tests. This data will be further refined and combined with the use of computer simulations to ensure our know-how remains the best in the world, and we are always on the lookout for new possibilities to apply this knowledge in environmentally conscious ways.

An exciting new trend in LNG-related applications is the growing number of Cold Recovery systems. The idea behind Cold Recovery is simple: energy has already been applied to liquefy the LNG and store it in cryogenic conditions. This LNG has then been transported elsewhere. If the LNG is simply vaporised and heated for use, its local cooling capacity is wasted. So instead, why not hook up HVAC or refrigerator systems to the LNG vaporisation process? This way, there is no need to expend further energy on creating artificial cold. With our 30 years of experience in the refrigeration industry and natural refrigerants like ammonia and CO_2, we have a good understanding of both sides of the Cold Recovery process. This enables us to pool our assets and knowledge on related application development.

The road we have travelled has brought us to the point where we can truly call ourselves experts. We have done countless simulations and tests, have close to 20 years of continuous experience in the field, have delivered over 300 heat exchangers to cryogenic LNG applications, and have been involved in more than half of the current LNG-powered marine vessels on the planet. With this list of merits, we can proudly say we are the industry leaders. Our Plate & Shell technology is not some exotic newcomer on the market, but a well-proven industry standard solution on land and on sea.

This path has only been possible with dedication, hard work and collaboration with our partners and customers, and we look forward to continuing on that road by developing tailor-made solutions for our customers and meeting future challenges.

In addition to short-term goals, Tobias Häggblom sees a bigger picture in his work: 'Our product is meant to last for decades rather than only focusing on the next quarter.'

Motivated by Teamwork and Seeing the Bigger Picture

Tobias Häggblom works as a Business Manager responsible for our Energy team. In his daily work, he enjoys rising to a challenge instead of giving up and finds meaning in working for a company with sound values.

What's your role at Vahterus?
I started in 2006 as a Sales Engineer, then became a Key Account Manager in 2008 and a Sales Manager in 2012. Since 2014, I've led our Energy team.

What do you like best about your job?
I like the mixture of technical challenges, sales and management. We have a great team of people.

How is your typical day at work?
The days vary greatly. One day can be an office day, working with heat-transfer solutions. The next day I might be travelling to the other side of the globe and working with our clients to find the best solutions for them.

When do you feel you've succeeded in your work?
In a sales environment, hitting the budget is of course your main target. It's always great when the whole team can celebrate work well done. It's also rewarding when you're able find good solutions to challenges.

What kind of situations bring out your best qualities?
I rarely give up. I like to take on a challenge, and I like the reward when it's overcome.

What do you consider Vahterus' most important value?
Sustainability. It's embedded in the business and the product, which is designed to last for decades.

If you weren't at Vahterus, what would you be doing?
Engineering has always been my passion and choosing what to study was never difficult. I graduated Master of Science in Technology from Åbo Academi University. If my job wasn't related to engineering, I'd probably be working with something sales-related.

How do you spend your time outside work?
I have three kids aged eight to ten, so coming up with ways to pass the time is never an issue. If there is extra time, I like to do things with my hands, like DIY projects, or golf or fishing. I used to do cross-country skiing but had to change to mountain-biking due to the poor winter conditions.

In the midst of everyday life, what delights you?
Spending time with my family. It gives a great balance when you come home after a stressful day at work.

What have you found positive about the experience of the coronavirus crisis?
I'm impressed by how well remote teaching works now that the Finnish schools are closed. My wife is a teacher, and she's currently doing several video conferences a day. Applications such as WhatsApp and Teams are making it all possible. I've also been really impressed by how well the kids work independently with their school tasks.

Which new skill would you like to learn?
A new language – Spanish, for example. I've read the basics, but it would be nice to speak it fluently.

Which of your co-workers would you like to praise?
I have to mention the entire Energy team. We have a really good mixture of people working very well together towards a common goal.

With Dekra Safety Comes First

Testing company Dekra ensures reliably and impartially that Vahterus heat exchangers meet all safety requirements.

Vahterus Editorial Team

Dekra is an independent testing company with official authorisation. The company is focused on technical inspections, conformity assessments, testing and certifications in different areas of industry. The purpose of its operations is to reliably and impartially ensure that basic safety requirements are met.

The design and manufacture of pressure equipment is regulated by legislation and, in addition to EU directives and standards, is subject to national regulations. Vahterus heat exchangers are welded pressure vessels that by law must be subjected to non-destructive material testing. Dekra is Finland's leading expert in non-destructive testing and Vahterus' chosen partner in this work.

Dekra Industrial Oy began its operations in Finland in 1974 under the name Polartest Oy. Today, the company is owned by Dekra SE, the third largest inspection and testing company in the world, with headquarters in Stuttgart, Germany. Vahterus began working with Polartest 25 years ago. With Dekra's acquisition, Polartest became part of Dekra, and the collaboration with Vahterus continued.

'For Vahterus, cooperation with Dekra is important', says **Matti Kontu**, Production Director at Vahterus, 'because its work is necessary for showing that the pressure vessel and its welds meet all the requirements'. The quality of metal structures can be measured by both breaking the material (DT, destructive testing) and without breaking the material (NDT, non-destructive testing). NDT looks for surface or hidden deficiencies in the material that may lead to failures or malfunctions. Research methods include surface and volumetric inspections.

´At Vahterus, virtually all basic testing methods are used, says **Jarmo Aitta**, Regional Manager at Dekra. 'Applied surface inspection methods include visual testing, magnetic-particle testing and liquid-penetrant testing. Fluorescent methods have also been used, but less frequently. In volumetric inspection, the most used methods are radiographic and ultrasound testing. Lately, there's been an increase in the use of digital radiography and phased array ultrasound testing.'

NDT is standardised, and at Vahterus, testing is performed by Dekra in two shifts daily. Four people work per shift and practically every product on the production line undergoes some non-destructive testing. The radiation space is lined with lead, which enables the use of radiography during a normal shift. All testing is performed at the Vahterus premises, but the testing equipment is the property of Dekra.

The test regulations and scope come from pressure vessel legislation, so that's not really in our hands', says Kontu. 'However, the more consistent the quality of Vahterus production is, the fewer errors are found in the tests, which then minimises the need for corrective work. The error rate is constantly monitored at the level of the entire production as well as the personal level of each welder.'

Aitta reports that the inspection methods have developed greatly over the years, and at Vahterus it has always been possible to introduce the most advanced methods at an early stage. Besides testing, the heat exchangers and their materials have evolved, which has led to new challenges in different inspection methods.

NDT is standardised, and at Vahterus, testing is performed by Dekra in two shifts daily.

'I personally think that Vahterus has invested in quality and strived to develop both welding methods and processes that alleviate testing. Various inspection-related aids have been created or even purchased for our assistance. Dekra has also been involved in testing new products made using new welding methods and production equipment already in the pilot phase. This has further increased the inspectors' motivation and expertise', says Aitta.

Dekra is also one of Vahterus' partners in destructive testing, as well as in the supervision of welding-method tests and proficiency tests. Destructive testing is performed on welds and base materials.

One of the key areas in the collaboration between Dekra and Vahterus has been the development of working methods and information systems. About five years ago, a new documentation management system was introduced, and for the past two years, all of Dekra's inspection reports have been completed electronically. The reports are automatically transferred to Vahterus' system within one hour of signing. All reports are also available to the inspectors who visit Vahterus, which makes it easier to keep track of the inspections and write new reports.

Dekra's Regional Manager Jarmo Aitta thanks Vahterus for its proactivity. 'I personally think that Vahterus has invested in quality and strived to develop both welding methods and processes that alleviate testing. Dekra has also been involved in testing new products made using new welding methods and production equipment already in the pilot phase. This has further increased the inspectors' motivation and expertise', he says.

At Vahterus, virtually all non-destructive testing methods are used. Applied surface inspection methods include visual testing, magnetic-particle testing and liquid-penetrant testing. Fluorescent methods have also been used, but less frequently. In volumetric inspection, the most used methods are radiographic and ultrasound testing. Lately, there's been an increase in the use of digital radiography and phased array ultrasound testing.

Necessity Is the Mother of Invention, Crisis Is the Driver of Change

The global challenges posed by the climate crisis, Covid-19 and the drop in oil prices are spurring innovation. Pharmaceutical companies are striving to produce vaccines and new medicines, while natural refrigerants and cold recovery through LNG are becoming increasingly energy-efficient solutions.

Chemical and Process

Marko Rantala, Sales Director at Vahterus

As the world fights the coronavirus pandemic, the outlook for the process and chemical industry has significantly changed.

Pharmaceutical producers are working hard to develop a vaccine against the virus, as well as increasing the production of the various medicines needed during these critical times. Looking at the list of heat exchanger units leaving our factory in Kalanti over the past few weeks, it is notable that the demand for reactor temperature control heat exchangers and solvent condensers used in pharmaceutical production facilities has radically increased.

Lockdown and social distancing have led to innovation and rethinking of the way we work. Operating from home without personal contact with colleagues and customers has forced us to use new technologies and alternative means of communication.

The outlook for Vahterus' business in the chemical sector during 2020 remains positive. We now have the new PSHE 12 model fully tested and ready, and it is well-suited to many applications in the industry.

One of Vahterus' long-term customers in the chemical industry, German giant BASF, has launched a campaign called 'Helping Hands': it is donating to healthcare facilities over 100 million protective masks and 1 million litres of disinfectants in Germany alone. BASF has also started the production of hand sanitisers in other countries in order to donate them to fight the virus. This is just one inspiring example of a company giving back to those in need at a time of crisis.

Energy

Tobias Häggblom, Business Manager at Vahterus

If I'd written this article before the end of last year, its tone would have been completely different. Although 2019 was far from the best, it was a solid year in the energy business, with a good level of investment.

The drop in the price of oil brought turmoil at the beginning of this year, as more and more news about the coronavirus outbreak started spreading from China. However, this wasn't the only reason why oil prices dropped so significantly. The price war between Russia and Saudi Arabia dragged out the decision to cut production. Thus overproduction and full storage resulted in a negative oil price for a short time. The price is now slowly climbing back.

Luckily, the price of oil isn't the only driving factor for energy investments. Environmental regulations are strongly pushing investments towards gas and LNG. This spring, Vahterus R&D team has been working on an interesting series of tests related to cryogenic applications. As the use of LNG increases, so do the possibilities to recover cold from LNG in different applications. Recovering cold means getting close to the freezing limits of brine. It's therefore extremely important to understand how low it's possible to cool brine.

Shipping continues to get greener. An increasing number of ships, both new and converted, are running on low-emission fuels. You can read about the possibilities offered by Vahterus Plate & Shell Heat Exchanger solutions in this magazine. There's plenty of potential for growth and innovation in this industry, even with lower oil prices.

Refrigeration

Heikki Oksanen, Business Manager at Vahterus

The biennial main event of the refrigeration was scheduled to take place in Nuremberg this fall.

Writing this statement in June, there's a lot of uncertainty in the air. China Refrigeration Expo 2020 in Wuhan was postponed, the 2020 IIAR Annual Conference in Orlando was canceled and we've just received a notice of cancellation of Chillventa 2020, launching a virtual event this October. The coronavirus pandemic has dominated front pages this spring.

Additionally, this past winter has been the warmest recorded in Europe, scientists have announced, with snow having to be imported for winter sporting events. In Helsinki, Finland, the average temperature for January and February was more than 6°C higher than the 1981–2010 average. Meanwhile in the Southern Hemisphere, record-breaking temperatures and months of severe drought have fuelled a series of massive bushfires across Australia.

There's no denying it, the climate is changing. And we must look to the future. Natural refrigerants, energy recovery and heat pumps are one of the key solutions to building a clean and safe environment for the next generations.

Here's hoping we're able to get together soon and seize the opportunity to discuss these significant challenges together. We've already been very effective in implementing the decreased use of refrigerants with ozone-depleting issues to safeguard our environment. Together, we can develop further safe and sustainable solutions to tackle the climate crisis.

One Vahterus Combined Chiller Cools Two Ice Rinks in Maryland

Jonathan Pascoe, President at Vahterus Americas and Mikko Tuomainen, Key Account Manager at Vahterus

In September 2019, Vahterus supplied PSHE 8/6HH-460/1/1 unit, a critical-charge combined ice-rink chiller, to Ultimate Fabrication Inc, located in Edmonton, Alberta, Canada. The unit was commissioned in October 2019 and it has been running as a part of new cooling system for Cabin John Ice Arena in Rockville, Maryland, USA. The Vahterus PSHE Combined Chiller (a chiller with an integrated separator in one shell) was a key component in the upgrade project of the NHL and studio-size ice rinks in the Cabin John Ice Arena.

This single heat exchanger solution was designed with two different-sized (separate) plate packs, using one common NH_3 chamber. The larger plate pack was designated to cool the NHL-sized arena, with the smaller plate pack providing cooling for studio-size rink. Each plate pack chilled different flow rates of ethylene glycol from -7.5°C (18.5°F) to -9C (15°F), with the NH_3 evaporating at -12 °C (10°F). This novel installation allows the rinks to run either independently or consecutively, providing a compact and cost-effective solution for the end customer.

The building package leaving Ultimate Fabrication. The 15 m (150 ft) long trailer weighed 50 tons (110,000 lbs).

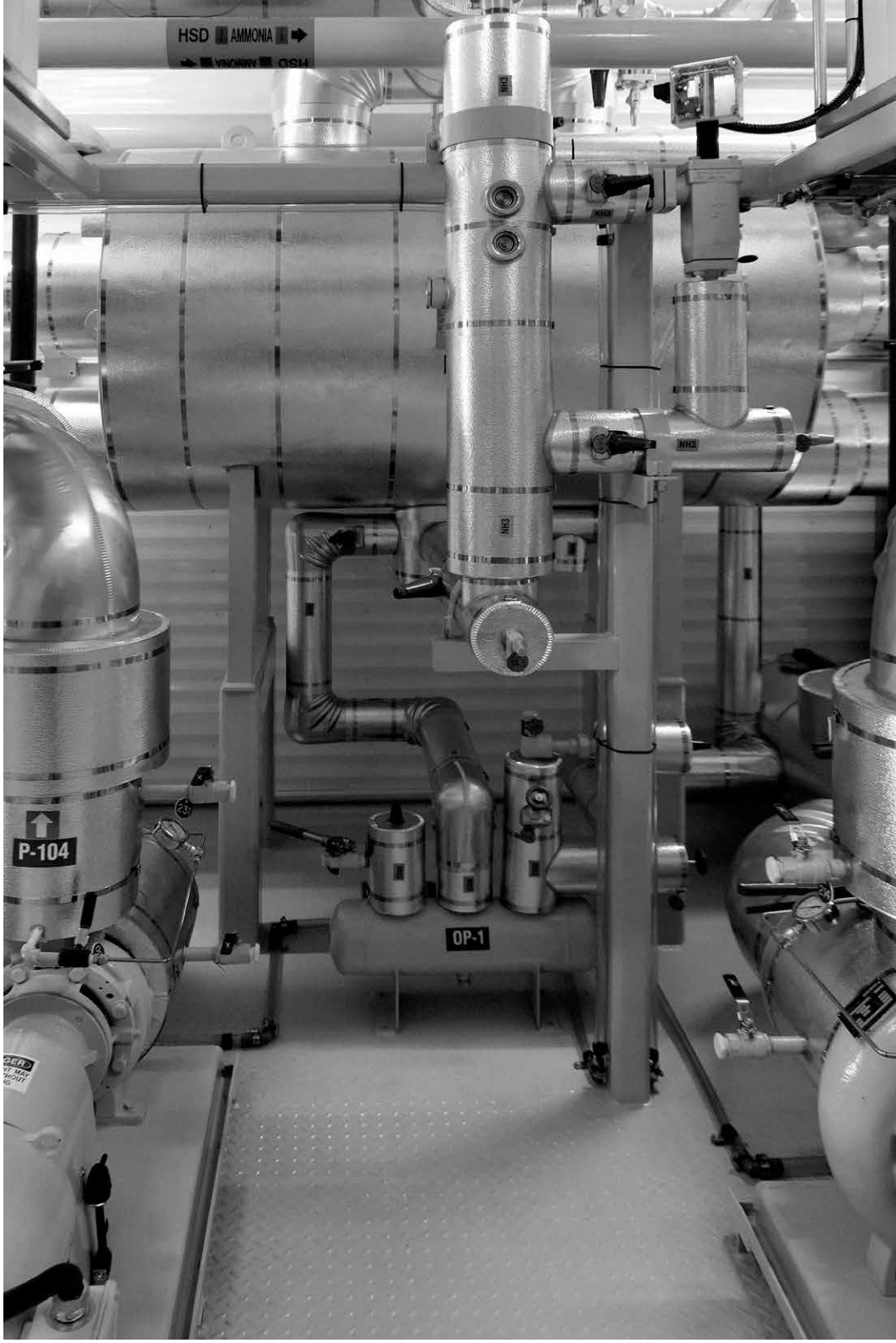
The chief designer of the cooling system was **Art Sutherland** of Accent Refrigeration, a natural refrigerant advocate, who has been working together with Vahterus for over a decade.

'We designed the system to optimise both electrical efficiency and thermal efficiency', said Sutherland, 'as well as totally eliminating thousands of pounds of high GWP and ozone-depleting refrigerant. By removing all the equipment from the former indoor machine room, more valuable building space would become available.'

The system that was removed was a direct refrigeration system with over 3,630 kg (8,000 lbs) of R-22 inside the public space. With the new Vahterus low-charge system, the arena facility now has less than 225 kg (500 lbs) of ammonia in a self-contained machine room outside of the public space.

Sutherland continued 'The new system, utilising ammonia, as well as highly efficient Mycom M compressors and a very close-approach Vahterus chiller, is appreciably more efficient than the previous direct refrigeration system.' The new system has two 125 horsepower compressors compared to the old system with two 150 horsepower compressors. Additionally, the new system operates on one compressor with run times approximately 20% less than the old system.

This new cooling system was designed with an environmental gain in mind, not only by switching from R-22 to ammonia, but also by maximising electrical and thermal efficiency. Key to achieving this was the fact that the entire design concept embraced technological advances. Change can often bring uncertainty and fear, but as can be seen in this case, with the correct design and the right components, the operational and environmental gains are considerable.



Vahterus Combined Chiller inside the arena package. The new cooling system was designed with an environmental gain in mind, not only by switching from R-22 to ammonia, but also by maximising electrical and thermal efficiency.

Cryostar's Saturation System Transforms Truck-Fuelling Stations

Vahterus Editorial Team

Founded in 1972, Cryostar specialises in designing and manufacturing cryogenic equipment. The company offers turbomachines, gas heaters and vaporisers, pumps, turbines as well as compressors for industrial gas, energy and hydrocarbon applications. In the twenty-first century, the company has extended its range to process plants in the fields of natural gas and clean energy.

Cryostar employs 500 people at its headquarters in Hesingue, France, in the centre of the three-border region constituting France, Germany and Switzerland.

90% of the company's production is exported. During almost five decades in operation, Cryostar has developed an international network through distributors and agents in Italy, Spain, Japan, Korea, India, South America, alongside its own branches that employ 100 people in the UK, Singapore, China, Brazil and the US.

Cryostar has been involved in LNG applications for several decades. In the year 2000, the company was one of the pioneers developing truck-fuelling stations. Two kinds of truck technologies co-exist and they require different pressures and temperatures in the reservoir. Initially, the standard fuelling stations included a device to heat and saturate LNG in the storage tank.

As a technological leader, Cryostar saw an opportunity to change this. The company decided to develop an 'on the fly' saturation system that would warm the LNG on demand when fuelling the truck.

Compared to the old technology, the two main advantages of this solution are the ability to:

– deliver low temperature LNG to trucks that support it, and therefore increase their autonomy and avoid any possible vent of their storage tank

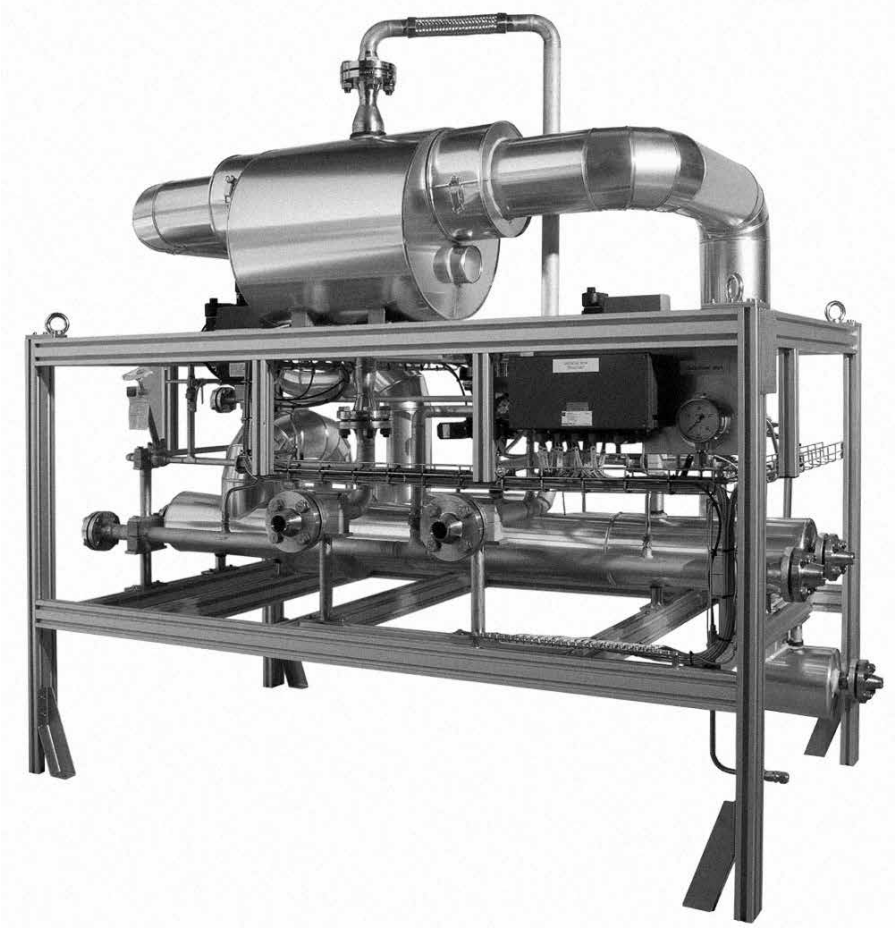
– keep cold LNG in the storage tank and reduce or avoid the need to cool it down, which requires plenty of energy. This creates significant energy saving, leading to an optimised environmental aspect.

In order to perform quick cooling down and avoid heat ingress into the system, Cryostar was looking for a compact and high-efficiency cryogenic heat exchanger. At Cryostar, selecting suppliers is a key activity, where purchasing, QHSE and engineering teams work together on an evaluation matrix. In this case, Vahterus was selected as a partner mainly for its product's technology, design and calculation capacity.

Cryostar was able to adjust its process so that it resulted in optimised size and heating capacity of the heat exchanger. An engineering expert from Cryostar participated in a class at Vahterus premises in Finland, and was then able to make all calculations on his own. The two companies exchanged 3D models, which were compatible, and by the time the first heat exchanger was shipped, no support from Vahterus was needed for installation.

Today, Cryostar is convinced it made the right choice when selecting Vahterus as a partner. The company has been able to deliver saturation system units to Canada,

Cryostar was looking for a compact and high-efficiency cryogenic heat exchanger. Today, the company is convinced it made the right choice when selecting Vahterus as a partner. The first Vahterus heat exchanger was installed in 2013 and is still in operation, alongside roughly 60 further Vahterus units in Cryostar's systems.



Vahterus Plate & Shell Heat Exchanger integrated into Cryostar's saturation system. The first Vahterus unit was installed in 2013.

Australia and Europe and more recently has qualified the design for Shell.

Because of the challenging operating conditions, the Vahterus heat exchanger is a good solution for Cryostar's system. Besides being compact in size, its fully welded structure eliminates the need for a gasket that could easily break in such a low operating temperature.

The first Vahterus heat exchanger was installed in 2013 and is still in operation, alongside roughly 60 further Vahterus units in Cryostar's systems today. This kind of long-term cooperation is extremely valuable for Vahterus, deepening the understanding of how the market, and possible applications for heat exchangers, are evolving.

Experts at Cryostar consider LNG the perfect transition fuel between oil and the future mix of greener sources of energy. When used as a fuel, LNG or CNG reduces CO_2 emissions; it drastically decreases particle emissions and is less noisy than diesel-driven engines. Moreover, it allows an easy transition to bio-LNG, a completely CO_2 neutral fuel.

LNG can be used for replacing LPG and oil in industrial applications, diesel for road trucks, gasoline and diesel for personal cars, heavy fuel oil or other fuels for ships, as well as any other energy source for power generation.

In the future, more and more of our built environment will be powered by renewable sources of energy such as solar, wind, hydrogen, biofuels and biogas. However, there are still major issues to be solved – for example, energy storing and learning to use different sources of renewable energies for different applications.

Until the new technologies have become established, LNG helps to fill the gap by continuing to supply different applications while slowly reducing the footprint on the environment and enabling an easy transition to biogas.

LNGenius: Clever Cold Energy Recovery in Spain's Ports

Grigory Konkov, Key Account Manager at Vahterus

Enagas is a company with 50 years' experience of working with the gas supply, both in Spain and globally. It owns and operates the Spanish national gas grid, as well as having a presence in other EU-countries and in Latin America.

With a team of three to five people, e4efficiency is a small department within the giant Enagas corporation. A kind of R&D hub, it tests and develops projects that can be scaled up later. Its projects in progress deal with the production, transport and commercialisation of the cold energy inherent in LNG. While minimising carbon footprints, such cold-harvesting projects also lead to economic savings and bring new businesses to under-used port areas, where the LNG is processed.

Vahterus' first communications with Enagas in general and with e4efficiency in particular began back in 2012. 'We received very good references about Vahterus products from people in our Bilbao regasification plant, where they have one heat exchanger operating with excellent results', says **Ana M. Azuela Gómez**, Project Engineer at e4efficiency. 'Our refrigeration specialist also recommended Vahterus Plate & Shell Heat Exchangers because of their cost, size and operation. We received recommendations from both the regasification and industrial world, so we had no doubt when choosing a heat exchanger.'

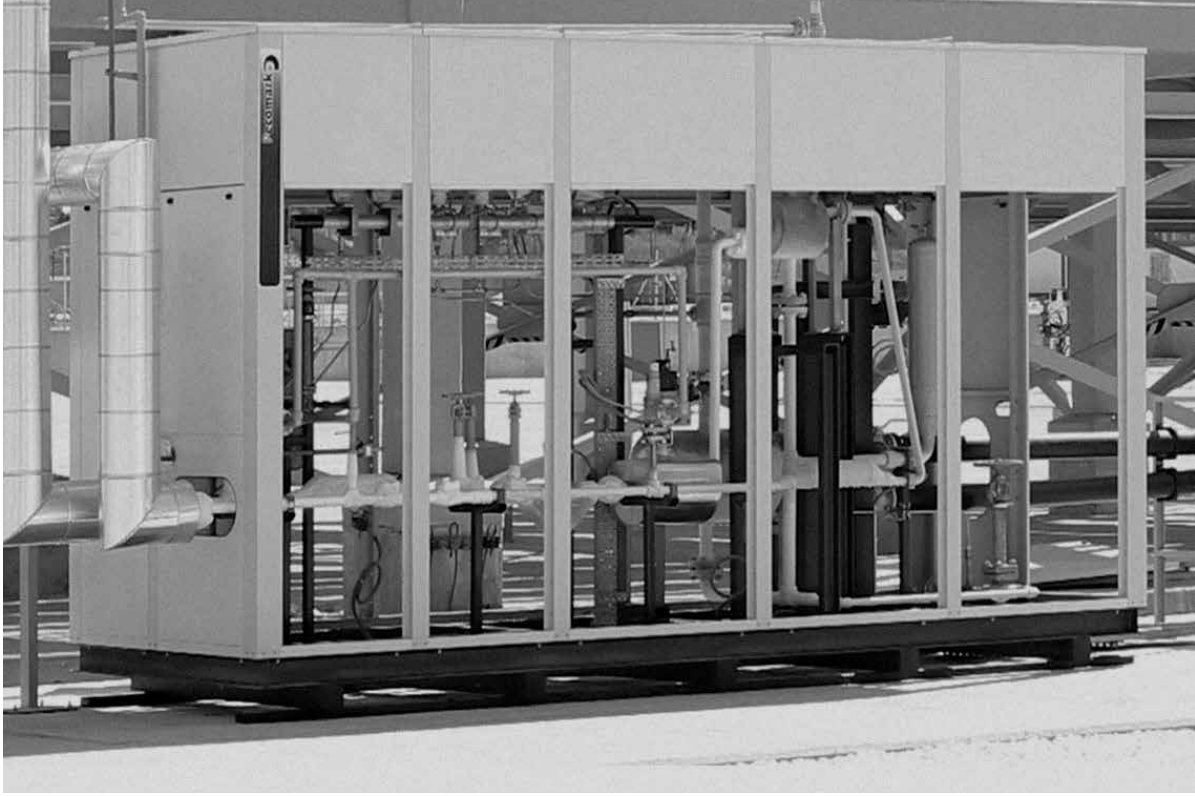
One of the ideas developed between Vahterus and e4efficiency was to utilise cold energy from the vaporisation of LNG. With conventional technologies, this was dumped into the sea, but e4efficiency saw a potential for its use as a source of cheap energy for logistics centres surrounding harbours. Savings on electricity will attract companies closer to the harbour.

Vahterus' willingness to innovate and experiment was also an important factor: 'There's a very good relationship between e4efficiency and Vahterus, not only on a commercial level, but they also help us continuously in new studies and proposals', says Azuela Gómez. 'They're open to researching new exchanges and processes, which is greatly appreciated by an innovative start-up like e4efficiency. We'd also like to highlight the fast response that we receive from Vahterus in all technical aspects.'

From the very beginning, the focus of discussions was on the applications related to the use of LNG. One of the ideas developed between Vahterus and e4efficiency was to utilise cold energy from the vaporisation of LNG. With conventional technologies, this was dumped into the sea, but e4efficiency saw a potential for its use as a source of cheap energy for logistics centres surrounding harbours.

As a result of collaborative thinking, Vahterus and Enagas developed a 'cold box' system, which consists of an exchange system and pumps. The pumps propel the refrigerant towards the client's facilities in a closed loop, at the temperature they require.

In this system, high-pressure LNG is passed through an exchange system of two Vahterus heat exchangers, one with LNG/intermediate fluid and the other with intermediate fluid/refrigerant fluid. The intermediate fluid circulates between the exchangers through a process



Vahterus and Enagas developed a 'cold box' system, which consists of an exchange system and pumps. The pumps propel the refrigerant towards the client's facilities in a closed loop, at the temperature they require.

of thermosiphon, and through the difference in density between the liquid phase and the gas phase, without the need for pumping. The temperature of both the intermediate fluid and the refrigerant may vary, depending on the needs of the customer. The cold energy of the LNG is recuperated, and can be made available to clients who require it, from refrigerated warehouses and ice factories, to industrial, pharmaceutical customers, data centres, etc. In theory, it will become a trouble-free solution with no risk of freezing the CO_2 or the Temper (the refrigerant), since the LNG does not come into direct contact with them, but transfers cold energy through the intermediate fluid.

This idea was first tested with a 35 kW skid from 2018 to 2020, with positive results. The second prototype, with a capacity scaled up to 370 kW, is getting ready for start-up in the coming months in Huelva, Spain. Azuela Gómez remarked: 'We've had a very good experience with the two Vahterus exchangers that we have in the LNG cold-harvesting prototype. Both the LNG / Ethane and the Ethane / Temper systems work perfectly, with an adequate temperature transmission speed and without requiring a cooling curve that's too slow. Furthermore, during the prototype start-up, two Vahterus technicians were present, which was very helpful for us.'

Having looked at the results of the two test skids, Enagas has begun two 'full-scale projects this year, amounting to 14MW of cold-energy recovered using this technology: project 'Barcelona' and project 'Huelva'. These are harbour locations in Spain, where Enagas receives LNG from tankers and will be able to develop the surrounding area by attracting companies to move closer to the harbour. In those projects, it is expected that end clients will make 25–40% savings compared to the use of electricity, when moving their facilities closer to the port. And this is just a beginning: with the demand for cold energy increasing around the globe due to global warming, there will be plenty more projects to come.

According to Azuela Gómez, e4efficiency will continue to work with Vahterus: 'Due to the good results obtained so far, we hope to keep working with Vahterus Plate & Shell Heat Exchangers, even improving on these great results and implementing this technology in new processes with LNG as the protagonist.'

Safe Production Expansion with Ammonia Glycol Chiller and Pumping Skid

Mack Hajjar, Projects Engineer at Tri Tech Refrigeration Australia

Established in 1994, Tri Tech Refrigeration Australia is one of the leading industrial refrigeration service and contracting providers in Australia, with a particular focus on the natural refrigerants ammonia and CO_2.

Zammit Ham & Bacon Curers is a family owned and operated company whose humble origins date back to 1954, when Francis Zammit, a butcher by trade, migrated from Malta to Australia and with the help of his sons, began producing Maltese sausages for the local community. In 1958, the Zammit family expanded its business and began producing hams – the products for which the company is now renowned. Zammit Ham & Bacon Curers handle the production of small goods through all its stages and create a unique product by utilising the latest technological efficiencies to control and monitor the curing, cooking and packaging of the products at their factory premises in Pendle Hill, Sydney.

The ammonia refrigeration plant at the Zammit's Pendle Hill facility was designed, installed and commissioned by Tri Tech Refrigeration Australia in 2014. In 2018, two new production areas for small goods slicing, packaging and packing were built in a location far from the existing chilled glycol infrastructure. Therefore, a remote glycol chiller and pump skid was needed that could be connected to the existing high-ammonia, high-pressure liquid and dry-suction mains and also fitted to new localised glycol mains services in the two new production areas. Glycol, rather than ammonia is commonly used in production areas occupied by people for safety reasons.

The proposed glycol chiller and pump skid needed to use ammonia, the plant's primary refrigerant, to cool a 30% propylene glycol solution, which in turn was used as a secondary refrigerant to provide refrigeration for two new production areas operating at between 8°C (46.4°F) and 12°C (53.6°F).

A 250kW (71 ton) heat exchanger was required that could cool incoming 30% Propylene Glycol at 1.5°C (34.7°F) to -3.5°C (25.7°F) using ammonia at a saturated evaporating temperature of -9°C (15.8°F).

After evaluation of various heat exchanger types and configurations, Tri Tech Refrigeration Australia opted for a Vahterus PSHE 5/4HH Combined Plate & Shell Heat Exchanger for the following reasons:

– Compact size: relative to 'conventional' flooded plate heat exchangers, two of which were of similar capacity and installed elsewhere in the plant in 2014, the Vahterus unit selected allowed for a skid with a smaller footprint.

– Cost reduction: the Vahterus unit selected allowed for an overall reduction in skid cost given that there was no need for an external surge drum and interconnecting pipes and valve. Insulation was also simpler, allowing for a further cost reduction.

– Improved safety: the fully welded design reduced potential for leakage compared to semi-welded/gasketted or brazed plate heat exchanger units.

The skid configuration features:

– Level control: Danfoss SV4 pilot float and PMFL 80-3 main valve, allowing for faster commissioning time and fewer PLC controls.

– High level protection: Hansen HLLe float with high-level cut-off on EVM NC pilot fitted in SI port of PMFL 80-3 and a secondary ammonia suction trap downstream in the main plant (desirable but not essential).

– Pressure protection: dual Hansen relief valves set at 1800kPa (261 PSI) on the shell side and glycol circuit fitted with 600kPa (87PSI) pressure relief.

– Ammonia controls: suction line fitted with Danfoss ICS 80-3. SI & SII ports fitted with EVM and CVP, allowing on/off control at -9°C SST (201kPa(g)) (15.8°F (29.15PSI)). P port fitted with CVP set to relieve at 0°C SST (328kPa(g)) [32°F (47.57PSI)).

A 250 KW pumped glycol skid with Vahterus Combined PSHE in service at Zammit factory in Sydney, Australia.

– Glycol controls: glycol set at full flow with minimum flow bypass without using pump VSD. Glycol temperatures controlled by opening and closing the suction EVM (and therefore opening/closing) main suction valves to achieve glycol leaving temperatures within a -3°C (26.6°F) / -4°C (24.8°F) dead band.

The unit was installed in December 2017 and commissioned in March 2018. There were no performance, temperature or pressure-drop related issues, and satisfactory level control and oil draining/oil drain sump volume.

Issues experienced during commissioning involved high ammonia levelling on start-up due to elevated glycol temperatures. This was remedied by programing a pump-out cycle on unit shut-down and pulsing the ammonia liquid feed on start-up. A bigger shell size for initial surge on start-up is an alternative but more expensive solution.

This unit was the first Vahterus PSHE Combined integral to an in-house Tri Tech Refrigeration Australia design to be purchased, installed and put into service. Since then, the cooperation between Tri Tech Refrigeration Australia and Vahterus has continued with the:

– commissioning of two US-built packages with on-board Vahterus glycol chillers in January 2018

– in-house design and installation of two other green-field plants using three ammonia/CO_2 cascade condensers commissioned in January 2019 and January 2020

– installation and commissioning of five NewTon packages built by Mayekawa with Vahterus Plate & Shell technology in July 2019

– in-house design of another ammonia glycol chiller with an 800kW (227 Ton) capacity due to be built and installed in Q2 2020 and commissioned in Q3 2020

– selection of additional units for conceptual designs for potential future projects requiring Combined in ammonia/CO_2 cascade, ammonia desuperheating, glycol chilling and ammonia sub-cooling/economising applications.

CO_2 Cold Store Operates with Energy Efficiency and Sustainability in Eastern China

Yonghai Yi, Senior Sales Engineer at Vahterus China

Panasonic Appliance Refrigeration System (Dalian) Co., Ltd is one of the leading refrigeration system and industrial refrigeration turnkey project providers in China. The company has successfully completed several green cold-chain projects for Chinese e-commerce market leaders, many of them based on the natural refrigerant CO_2.

Huachen Longdefeng Group has a diversified business portfolio, including real estate, financial investment, asset management, food importing and logistics. The e-commerce boom in China created strong demand for the group's logistics business. In 2017, Huachen group invested in a new energy-efficient logistic centre. Panasonic won the refrigeration contract.

The centre has cold stores in two three-storey buildings. Each storey has a floor area of 7,500m^2. In Complex No.4, the high temperature zone has three cold rooms with a design temperature of 0 to 5°C. It can store up to 1,770 tons of goods. The low temperature zone has one cold room with a design temperature of -23 to -25°C. It can store up to 16,450 tons of goods. The deep freezing zone has one cold room with a design temperature of -55 to -60°C. It can store up to 800 tons of goods. The buffer zone has one cold room with a design temperature of -25°C. In Complex No.5, the low temperature zone consists of 17 rooms with a design temperature of -18 to -20°C and it can store up to 19,090 tons of goods. Both buildings have a passage and processing area designed at 5–10°C.

Panasonic supplied an energy-efficient refrigeration system with Vahterus PSHE to Huachen Group's green cold store.

Panasonic designed R507/CO_2 refrigeration systems for cold rooms -23 to -25°C in Complex No. 4 and cold rooms -18 to -20°C in Complex No. 5. In these systems, CO_2 operates as brine. Each complex has two independent CO_2 systems to ensure that the goods stored in them are safely preserved.

The cascade heat exchanger is a critical piece of equipment between the two refrigeration systems. The Panasonic team made a thorough technical evaluation of different heat exchanger technologies and brands. Vahterus was chosen to supply the PSHEs for this project due to its strong market reputation and the technical advantage of its PSHEs. The compact size lowers the system refrigerant charge. High heat transfer efficiency enables closer temperature approach between R507 and CO_2. High suction pressure helps in reducing system energy consumption. The fully welded construction of PSHE also minimises leakage risks and is maintenance free.

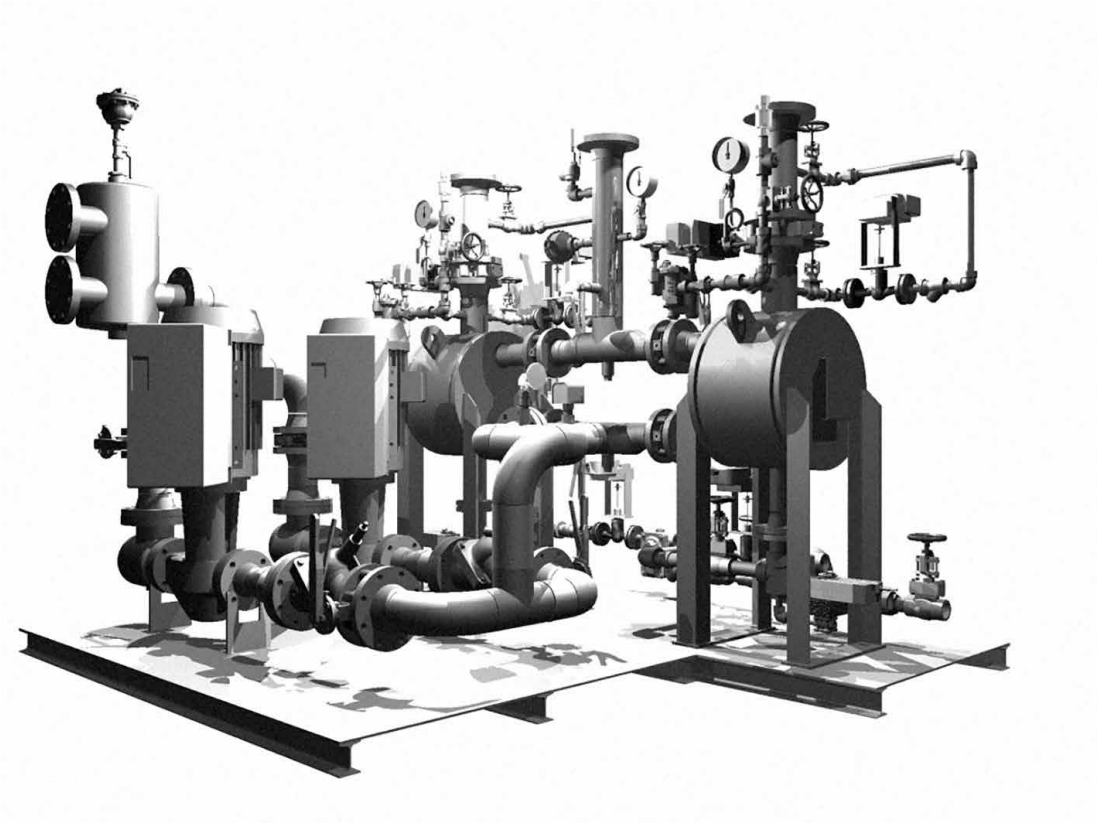
The PSHEs were installed in October 2018. Huachen's project further proves that Vahterus is the right choice for demanding CO_2 refrigeration systems. This adds another successful green cold-chain project to Panasonic's portfolio. The journey continues!

The Beauty of Being Compact: Efficient building-heat packages open doors in Canada

Leonardo Berardinelli, Vice-President Production Division at Preston Phipps Inc, Montreal

Since 2010, Vahterus has been providing Plate & Shell Heat Exchangers for building-heat packages manufactured by Preston Phipps for the Canadian Market.

In the early 2000s, there was a change in the approach to providing building heat for the institutional and commercial markets. In the past, contractors put together packages on site, based on drawings and specifications provided by the design consultants. Once these systems were installed, the end-user and maintenance personnel were faced with many different systems throughout their facilities. After the warranty period ended, service became difficult because no



Vahterus provides Plate & Shell Heat Exchanger design for building-heat packages manufactured by Preston Phipps. The compact design makes it possible to manufacture skid assemblies that can handle large loads and take up a much smaller footprint.

single-source vendor was responsible for the system, and facility maintenance staff became increasingly frustrated by having to deal with multiple vendors for support.

As the years passed, buildings aged and so too did the building heating systems. Replacing huge Shell & Tube heat exchangers without demolishing existing architecture was challenging. New buildings were designed with smaller mechanical rooms. The old design model needed to be rethought and a different approach was required.

Design consultants were now looking for packaged solutions that were manufactured and designed by a single-source vendor, who would later be the sole responsible vendor for maintenance and any possible issues. Faced with this challenge, Preston Phipps decided to look at building heat differently. The idea of conventional steam-side controlled Shell & Tube heat exchangers needed updating. Although this design worked well, smaller mechanical rooms and more energy-efficient design criteria meant that it was time to look for alternative solutions.

Since steam was the energy source, the idea of looking at condensate-controlled, or flooded, heat exchanger solutions was the path forward. The design's simplicity meant better control, less equipment and a smaller footprint. In addition, the market was asking for maximum energy savings, which could be achieved by the sub-cooling condensate. The last challenge was getting away from the traditional Shell & Tube heat exchanger and finding a different technology that was efficient and compact.

And so the success story began! Vahterus, provided us with the Plate & Shell Heat Exchanger design.

The move to a new compact design has opened the doors to countless opportunities. Throughout the years, hundreds of rationalised building-heat packages have been sold across the Canadian market. Designs have become standardised and many facilities are slowly replacing their older systems. The highly innovative design characteristics in such a compact product, and our continued partnership with Vahterus, have allowed us to succeed.

Their technology made it possible to manufacture skid assemblies that can handle large loads and take up a much smaller footprint in mechanical rooms. Older buildings could easily be retrofitted by moving these new packages through narrow hallways and elevators. Newer buildings could take advantage of the compact footprint and use the saved space for real estate.

The success of these packages eventually led to the trade marketing of COMPACKHEAT by Preston Phipps. Throughout the years, hundreds of these packages have been sold across the Canadian market. The move to this design has opened the doors to countless opportunities. Designs have become standardised and many facilities are slowly replacing their older systems and adopting the COMPACKHEAT way of thinking.

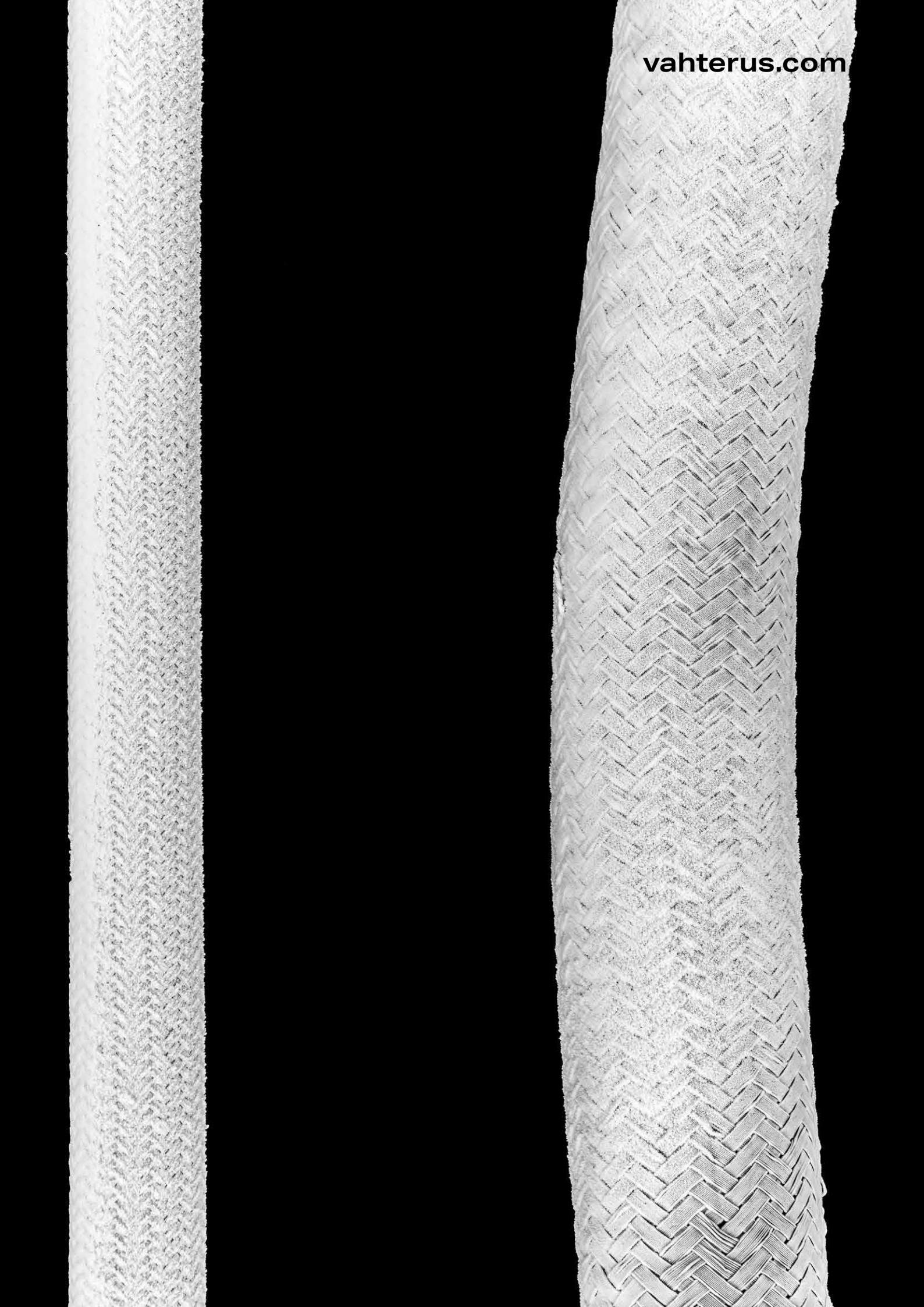
Vahterus Plate & Shell Heat Exchanger technology combines the superior heat transfer of the gasketed plate-type heat exchanger with the Shell & Tube tolerance for pressure and temperature. These highly innovative design characteristics in such a compact product, and our continued partnership with Vahterus, have allowed us to succeed.

Although Vahterus and Preston Phipps are in different countries, they share common values. Delivering a high-quality product, attention to detail and customer service are just a few examples of the appreciation and trust that our companies have for each other. Both organisations share business models that include re-investment, growth creation for valued employees and the willingness to meet objectives and challenges.

30 years in Heat Transfer

Vahterus' journey began in 1990. Through extensive R&D work and with 60,000 heat exchangers delivered to customers all over the world, we're now leaders in the field.

Read more success stories in the next issue where we celebrate our 30th anniversary.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