MTU Report is always on the spot

Whether in printed or electronic form, MTU Report keeps you informed at all times. Looking for detailed and in-depth reports? Then the print version of MTU Report is the one for you. Videos, image galleries, extra content on the magazine articles and current news can be found online at www.mtu-report.com. Want to keep up to date with the latest news from MTU and MTU Onsite Energy? Then subscribe to our monthly customer newsletter, MTU eReport. And if you want information even faster, you will find short versions of all the stories on our social media channels. Make sure you keep up with MTU!

www.mtu-report.com

The MTU 16-cylinder Series 4000 natural gas engine for commercial marine applications

MTUreport

The magnitude of the MTU and MTU Onsite Energy Brands | Rolls-Royce Power Systems Brands
Issue 01|2019 | www.mtu-report.com

Gas
A fuel for the future

5,500 meters above sea level
Mining engines run at high altitudes without power losses

Going app!
Digital products in operation on Lake Garda

Andreas Schell is CEO of Rolls-Royce Power Systems AG and Chairman of the Board of Directors of its subsidiary MTU in Friedrichshafen.

New breadth of vision at MTU

Dear Readers,
Puzzled by the image on the cover? It features two gas flames in our MTU colors – red and blue. In this issue, gas is our business, with the two flames signaling the shift underway as we evolve into a provider of integrated solutions. Now, our renowned diesel-based portfolio for drives, propulsion and power generation is making space for new solutions and alternative fuels.

One of the key planks of our re-alignment strategy is gas engines, and they are also a core element in our new plan for always delivering the optimum system for your individual needs, with all that means in terms of cost-effectiveness, efficiency and sustainability. The system we come up with might not necessarily be a diesel engine – it could be a gas engine or hybrid configuration, and it might involve an electric motor or a fuel cell. Nor will we focus narrowly on the drive technology – on the contrary, we'll be taking a holistic view of your entire system and its life cycle, including maintenance and service.

Gas as a fuel offers an array of advantages. In this issue of MTU Report, we've aimed to provide some inspiring examples of its use: We visit a farmer in Thailand who powers his plant very cheaply with gas, and our mobile gas engines with zero particulate and sulfur emissions are soon to power the ferries featured in a report from the Netherlands. We also cast a look into the future – a future in which fossil fuels no longer reign supreme, as synthetically produced alternatives offering clean, climate-neutral combustion move into the spotlight.

When it comes to developing the low-emission drive and energy solutions that best suit your needs, we want to retain our “preferred partner” status. To put it another way, we want to take care of engineering the best power solution for your ferry, haul truck, train or energy system, leaving you free to concentrate on managing your daily operations.

All in all, our business is set for an action-packed year in 2019. So keep abreast of developments over the next few weeks by visiting us online at www.mtureport.de.

Sincerely,

Andreas Schell

Gas

Keep up with MTU!

MTU Report always keeps you informed, whether you read the printed magazine, the online version at www.mtu-report.com or the MTUeReport bi-monthly newsletter. In print or in electronic form, you can always get the latest stories and news about MTU and MTU Onsite Energy wherever you are. And if you want information even faster, you will find short versions of all the stories on our social media channels.
Register here for MTU eReport: www.mtureport.com/newsletter

CROSSMEDIA

Gas for the future
Gas is a fuel that is set to play an increasingly important role in the future. Our title page pictures two gas flames in MTU colors. The background shows the molecular structure of methane, the main component of natural gas.

Green light for the hybrid drive

The Hybrid PowerPack, MTU's eco-friendly rail traction system, boasts an excellent sales outlook and is more than ready for series production. Letters of Intent have been signed by Irish Rail, operator of Ireland's national rail network, and British rolling stock leasing companies Porterbrook and Alpha Trains. Furthermore, German rail operator Abellio, rail solutions provider Alstom, and the Saxony-Anhalt regional rail transport service have jointly signed an LOI.

The agreements provide for short-term delivery of nine MTU Hybrid PowerPacks to Irish Rail, four to Porterbrook, and six to partners Abellio, Alstom and the Saxony-Anhalt regional rail service. The relevant contracts are now being drawn up and also include provisions for PowerPack order quantities in the three-digit range once the customers complete their trials. The PowerPacks will be retro-fitted to existing passenger train fleets.

"Only 60 percent of the German rail network is equipped with overhead catenary systems. The government's coalition agreement aims for 70 per cent by 2025. At the same time, CO_2 emissions in the transport sector have been stagnating at a high level now for years. Partial electrification using intelligent hybrid technology provides the solution to reducing emissions significantly without overhead catenary systems," pointed out Lars Kräft, Vice President Industrial Business at Rolls-Royce Power Systems.

MTU has spent the last few years refining its hybrid technology. Used in combination with the driver assistance system 'Intelligent Drive Manager' and a modern transmission, PowerPacks can facilitate fuel savings of over 30 per cent, depending on vehicle and timetable. Furthermore, the modular design of the Hybrid PowerPack allows it to be linked to a wide variety of transmission and battery systems, thus allowing individual solutions to be offered according to rail vehicle, application and route profile.

"The MTU Hybrid PowerPack impressed me very much – it is a perfect example of innovative and environmentally-friendly high-tech from Germany. It provides rapid mobility combined with lower emissions and a subsequent improvement in air quality. As a result of local emissions-free operation and the possibility of making up for delays, this drive solution makes rail travel significantly more attractive for passengers and local residents alike. In addition to that, this alternative drive system can make a major contribution to achieving our climate goals in local passenger rail transport. We should put this production-ready technology on rail in Germany as soon as possible and arouse the interest of new customers in rail travel," said Andreas Scheuer, German Minister of Transport and Digital Infrastructure. ■

The time has come for hybrids – read what the experts think about it on pages 44 and 45.

The supply of nine hybrid PowerPacks to state-owned Irish Rail has been agreed. Providing trials go well, all 234 railcars operating in Class 22000 trains will be repowered.

Operator Abellio Rail Central Germany, rail solutions provider Alstom and the regional rail service Transport Services Saxony-Anhalt GmbH (NASA) are planning to team up with MTU on integration of a new hybrid drive solution in Coradia Lint diesel trains in the Abellio fleet.

Alpha Trains intends to repower its existing Talent, Desiro and Lint rail vehicles with MTU hybrid drives. Following completion of the conceptual design and the conversion of an initial Series VT 643 (Talent) vehicle, the aim is to convert the entire Alpha Trains fleet to hybrid drive systems.

Great Britain's biggest rail vehicle leasing company, Porterbrook, is looking to convert Turbostar Class 168 and Class 170 railcars from straightforward diesel drive to hybrid electric drive.

Do you know Ulleungdo?

Ulleung Island rises like a land that time forgot over a rugged, forested outcrop of towering, jagged cliffs in the sea midway between South Korea and Japan. Around 135 kilometres from either shore, this spectacular tip of a giant, extinct volcano soars nearly 1,000 metres high around a grassland bowl interior crater, like a true-life Jurassic Park. Ulleungdo, as it is known in Korean, was for long so remote from either Korea or Japan that it remained largely uninhabited. Even the official location of this distant outcrop is, in a sense, geographical bipolar. South Korea calls it the East Sea; Japan knows it as the Sea of Japan.

In the recent past, another sector of the economy has grown in importance alongside fisheries: tourism. Curious visitors are drawn to one of the most spectacular landscapes in Korea. The idyllic traditional fishing villages along the coast and small farmsteads inside the crater make you forget the hustle and bustle of the modern world.

Perhaps the greatest attraction of all is Ulleungdo's sheer remoteness. For to this day there is no airport; so the only way of reaching the island is by ferry – on which the inhabitants depend for contact with the outside world. But the voyage, aboard ferry operator DAEA Express Shipping's 42-metre fast ferry *Sea Flower*, is not for the faint of heart. Depending on the weather, it can take 6 to 10 hours to sail the 160 kilometres from the South Korean port of Hupo. Because the East Sea/Japan Sea was once landlocked, with only narrow straits now connecting it to the oceans north and south, fast tidal waves surge twice daily while winter monsoons herald typhoons and storms with waves reaching eight to ten metres. Complex conditions are intensified by a meeting of cold and warm currents, creating haunting mists.

Especially in difficult conditions, powerful drive and high reliability are of great importance. Who could know better than Jeong Ho-Young, the chief engineer of the *Sea Flower*. The four MTU 16V2000M72 diesels aboard the ferry built by Damen Shipyards ensure uncompromising peace of mind even in the most adverse conditions. Since 2016, the vessel has been operating trouble-free on the route that is so important for Ulleungdo, He says, "Robust engines, systems unparalleled by any other manufacturer, low operating costs and reliable customer service all go to make MTU engines the best on the market." ■

Read the full story at
www.mtureport.com/Ulleungdo

MTU extends its microgrid expertise

Microgrids supply electric power to industrial sites, local communities and remote areas in an environmentally-friendly way and can also support the public grid. MTU will soon be providing full turnkey micro-grid solutions.

MTU is investing in Berlin-based start-up company Qinous GmbH, a global provider of innovative energy storage and control systems, and adding turnkey microgrids to the portfolio.

"As a strategic investor, the aim is to set up a partnership with Qinous for the development of innovative energy storage solutions and together offer cleaner solutions designed to meet tomorrow's needs," explained Marcus A. Wassenberg, CFO and Labor Director at Rolls-Royce Power Systems.

The increased use of renewable energies has exacerbated the challenge of how to maintain a reliable energy supply, when weather conditions are unfavorable, to meet demand. Autonomous electricity networks, or microgrids, combine cogeneration plants, diesel- and gas-powered gensets and renewable sources with batteries and a control system that links up all the elements in an intelligent energy management system that optimises the energy usage technically and economically. "With the use of energy storage and renewable sources, operators of hotels, hospitals or schools are able to make significant fuel cost savings and at the same time protect the environment," said Qinous CEO Steffen Heinrich.

Qinous has gained considerable experience in the integration of battery storage and energy systems in microgrids in more than 30 projects worldwide and has already integrated MTU Onsite Energy systems in such projects. The investment made by MTU is to be used to expand the existing product portfolio and strengthen global sales and marketing activities.

"We are looking forward to working with Qinous and see this partnership as yet another milestone as we expand our activities in this business segment," said Marcus A. Wassenberg. Financial details of the individual investment being made by MTU are not being disclosed.

Andreas Schell, CEO of Rolls-Royce Power Systems, added: "We have identified our customers' needs in terms of autonomous energy supply systems that are efficient, reliable and environmentally friendly. For this reason, we are now adding turnkey microgrids to our current portfolio. In addition to the diesel and gas gensets supplied by MTU Onsite Energy, together with our partners like Qinous we will now offer battery containers, including plants for renewable power generation, and combine that with intelligent control. This strengthens our position as a provider of innovative power solutions able to supply our customers with microgrid systems tailored to their specific requirements."

Faster Internet in the Arctic

MTU is partnering with Northwestel, a Northern Canadian telecommunications company, to help provide reliable high-speed internet access to Nunavut, one of the most remote northern territories of the Canadian Arctic. 23 MTU Onsite Energy diesel generator sets are to supply emergency power. They will be delivered as part of a network infrastructure improvement plan designed to increase connectivity, including internet speeds and broadband capacity, in the territory's communities.

"Projects like this one in Nunavut remind us how important connectivity and accessibility are to modern life," said Brian Ponstein, regional sales engineer, MTU Onsite Energy. "We are very happy to provide the power necessary to ensure this connectivity is always available to this remote region of the world."

As part of the Canadian government's "Connect to Innovate" program, Northwestel developed a comprehensive plan to upgrade the region's telecommunications infrastructure that includes the use of satellite technology with associated receiver dishes in each of the 25 Nunavut communities to increase bandwidth capacity. Each satellite-receiver pair will require backup power to ensure maximum uptime and guarantee service in the event of a power outage.

23 MTU Onsite Energy systems will provide backup power and enable uptime and connectivity in more than two dozen communities in Nunavut in Northern Canada.

Nunavut currently has download speeds of 1-3 megabits per second. The goal, in 2019, is to increase those spends threefold. Longer term, the Canadian Radio-television and Telecommunications Commission (CRTC), the governing body responsible for regulating the broadcasting and telecommunications industries, will require all households in Canada to have download speeds of 50 megabits per second within the next 15 years.

How to use renewable energies to make emergency power

Together with LEW Verteilnetz GmbH, MTU Onsite Energy and additional project partners from industry and science successfully tested a backup power supply concept based on renewable energy sources and MTU Onsite Energy CHP plants. The concept focuses primarily on the supply of emergency backup power for critical infrastructures, such as hospitals or drinking water supply systems. In the event of a power outage, they can be supplied with power from an islanded grid (microgrid) that is not connected to the national grid. Photovoltaic systems have not been used to provide a backup power supply to date, as these systems are dependent on an existing grid supplying a stable voltage and frequency. Such distributed generation units can now be made available to supply emergency backup power: a power plant with black start capability, in other words one that can start up on its own without the need for electric power, acts as the leading power plant and ensures that the frequency remains stable at 50 Hz. Due to the given power ratio this was performed by a hydroelectric power plant. The biogas plant based on MTU Onsite Energy gas generator sets was tested on its frequency stability. Photovoltaic systems thus recognize that a grid is in place and begin to supply the grid with electric power as if they were operating in a typical interconnected network. With the exception of modifications to the leading power plant, no retrofits to the systems are necessary. The concept can be applied quite well to other systems.

New digital tools for better support to powergen customers

MTU Onsite Energy opened a new Customer Care Center in Augsburg, Germany, focusing exclusively on customers of natural-gas-powered generator sets. This makes it one of the company's five new customer service centers that have been in operation since the beginning of 2018. Experts from MTU work together at different locations, and across several time zones, to support customers around the world when it comes to keeping their MTU Onsite Energy systems on the go.

The digital tools MTU Go! Act and MTU Go! Manage will soon be tested in the first power plants. They are replacing the data loggers previously used, and enable MTU experts and the customer to monitor the units remotely, plan maintenance and spare parts availability, analyze operator data and derive recommendations for improving product operation.

New digital tools for even better support.

Hybrid systems for marine applications

British luxury yacht manufacturer Sunseeker International will present the first yacht fitted with an MTU series production hybrid propulsion system in 2020.

The new Sunseeker yacht will have an integrated MTU hybrid propulsion system. It will consist of two MTU diesel engines, on-board generators, electric propulsion modules, transmission system, batteries and control and monitoring systems and can be expanded on a modular basis.

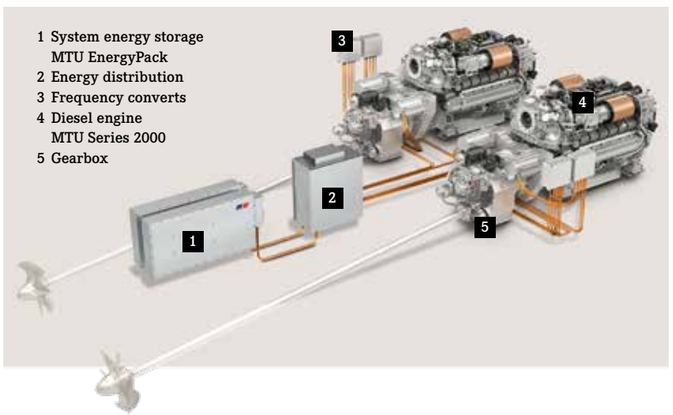
British luxury yacht manufacturer Sunseeker International and MTU have agreed to present the first yacht fitted with an MTU series production hybrid propulsion system in 2020.

Sean Robertson, Sales Director at Sunseeker International commented: “Sunseeker has always led the industry by innovating and being first to market so it is entirely appropriate that we are the first luxury performance yacht manufacturer to partner with MTU Hybrid Power which will revolutionise how all customers power their boats over the coming years. The way owners are using their boats continues to evolve with efficiency and noise reduction now as important as features and volume which all contribute to their ultimate purchase decision.”

Knut Müller, Head of Marine and Government Business at MTU, said: “The combination of diesel engines and electric motors, in addition to batteries and their variable areas of application, offers yacht owners significant benefits. Silent cruising, combined with low vibration and emission levels, offer tremendous gains in terms of on-board comfort. High performance levels, efficiency, environmental compatibility and the flexibility of the propulsion system are of great interest today when operating a yacht. We believe that the focus in the future yacht industry will be more and more on smart and innovative system solutions rather than just focussing on the power output level.”

The new Sunseeker yacht will have an integrated MTU hybrid propulsion system. It will consist of two 12-cylinder MTU Series 2000 diesel engines (each delivering around 1,432 kW/ 1,947 hp), on-board generators, electric propulsion modules, transmission system and batteries, control and monitoring systems and can be expanded on a modular basis.

The yacht will be provided with six different operating modes that are easy to operate, including the automated “smart hybrid” and “charge hybrid” modes, which enable all power sources to be used as required. In an “electric mode” the yacht propulsion and on-board power can be supplied continuously by the generators, providing optimisation of fuel consumption and comfort on-board for long and overnight passages. In “silent mode”, which uses power solely from the batteries, up to 40 minutes of propulsion and 120 minutes of on-board power are available with each pair of MTU batteries installed, with no emissions produced whatsoever.



Read more about MTU hybrid systems at **www.mtureport.com/electrification**

Record-breaking tugboat

For the first time, high-speed diesel engines are being used to power a 90-ton bollard pull harbor tug. This is a figure used to express the amount of force exerted by the tugboat. In fall 2018, four tugs from the Turkish Sanmar shipyard – powered by two 2,700 kW MTU diesel engines – proved in a bollard pull test that they are among the most powerful of their kind.

In the bollard pull test, engineers set up a tension balance between the boat's tow rope and a bollard. The tug was then operated at different power levels, with the scales showing how many metric tons of power the boat was able to produce.

To date, harbor tugs with bollard pulls of over 85 metric tons have more often been fitted with medium-speed engines. “High-speed engines are much more compact than their medium-speed counterparts, and also have lower price tags,” said MTU expert Andreas Müller-Hirlinger, explaining the benefits of the engines and the trend towards high-speed engines. For the Sanmar tugs, MTU has also reduced the speed of the 16V 4000 M73L engines from 1,970 to 1,850 revolutions per minute. The result is that the powertrain does not have to be interrupted by a gearbox, allowing the engines to deliver directly to the Schottel azimuth propellers.

The tugs, almost 30 meters in length and 6 meters wide, were delivered to the Svitzer shipping company in fall 2018 and will be used as terminal tugs in the Moroccan port of Tanger-Med.

For the first time, high-speed diesel engines are being used to power a 90-ton bollard pull harbor tug.

With MTU on the Canary Islands

Four 20V Series 8000 engines from MTU will power two new high-speed ferries run by Spanish ferry operator Fred. Olsen.

Two new high-speed ferries to be run by Spanish ferry operator Fred. Olsen, S.A. are each to be powered by four MTU 20-cylinder 8000 M71L engines. The ferries will be 117m trimarans, designed by Austal Australia, and are to ply the waters around the Canary Islands along with the world’s largest aluminum fast ferry in operation, the Benchijigua Express. It is also planned to sign a maintenance agreement for both new ferries covering a period of up to eight years and a maximum of 24,000 hours of operation. The Benchijigua Express has been in service since 2005 and is also powered by MTU Series 8000 engines.

Ivan Fernandez Martinez, technical manager at Fred. Olsen said, “The Benchijigua Express is a prestigious vessel in the world of fast ferries. It ticks all the boxes in terms of our high demands for power, speed and passenger satisfaction. On the back of this positive experience we have decided to install MTU engines in our new trimarans as well. These engines will be in service round-the-clock, and we need the best possible efficiency and fuel consumption coupled with low levels of downtime. We know MTU can deliver on this. Since being launched into service back in 2005, the Benchijigua Express hasn’t had a single passage canceled by engine issues.”

Each of the four engines in the new ferries will deliver 9,100 kW of power at 1,150 rpm. The trimarans will be able to accommodate over 1,100 passengers and up to 276 cars, and will be able to travel at speeds of up to 38 knots. Both ferries are to be delivered and undergo commissioning in 2020.

In brief:

New standby gensets: up to 4000 kVA

The new MTU Onsite Energy 20V 4000 DS3600 genset was recently launched on the market. Based on enhanced MTU Series 4000 engines, the 20V 4000 DS3600 diesel genset significantly outperforms previous offerings with a 10 percent uplift to around 3000 kW of electrical output (3730 kVA) in standby operation and some 2700 kW of electrical output (3390 kVA) when generating prime power. Earlier models of this Series 4000 engine have a proven track record with over 23,000 units sold for power generation applications.

More than 30 of these new units were already delivered in 2018.

Generator sets for UK Type 45 naval vessels

MTU is to supply MTU Series 4000 diesel generator sets to BAE Systems as part of the Power Improvement Project (PIP) to increase the resilience of the power and propulsion system in all six Type 45 destroyers. The two existing diesel gensets are to be replaced by three MTU gensets per vessel. The three MTU gensets will complement two existing Rolls-Royce WR21 gas turbines also supplying power to the electric propulsion system.

MTU will supply 265 MTU Onsite Energy 16V 4000 gensets for five new power plants in Chile.

475 MW for Chile's national grid

A consortium comprising EPC contractor TSK and MTU has signed an engineering, procurement and construction (EPC) contract with Prime Energía Quickstart Spa, a subsidiary of Prime Energia SpA (Prime Energía), for the construction of five power plants across Chile consisting of 265 MTU Onsite Energy 16V 4000 gensets. Prime Energía is a subsidiary of the New York-based Glenfarne Group, LLC ("Glenfarne"), a developer, owner-operator and industrial manager of energy and infrastructure assets. Prime Energía's five power plants will offer a total combined capacity of 475 MW, which will be connected to Chile's electricity grid to provide backup capacity to the country's power supply system.

Brendan Duval, Managing Partner of Glenfarne, said: "These plants are an integral part of Glenfarne's strategy to develop power infrastructure that supports the proliferation of renewables and the stability of the grid in regions across the Americas with great potential for growth. I am pleased to partner with such high calibre partners as TSK and MTU Onsite Energy on the delivery of these assets."

The order to deliver the power plants to the first three locations has been officially placed with the consortium, with the order for the two additional plants scheduled to follow shortly thereafter. The gensets will be digitally connected via gateways sending data to the MTU Go! Manage platform to monitor and analyse system data. The power plants will be remotely monitored and controlled in real time by Prime Energía's state of the art Network Operations Center in Santiago.

Chile is one of the fastest growing economic powers in Latin America. Demand for energy is expected to grow at an annual rate of 4 percent over the next five years, and the country expects to benefit from the vast availability of renewable power sources. The percentage of renewable energy in the Chilean power mix is growing at a constant rate: its share, in terms of installed generation capacity, has more than tripled since 2012, and in 2017, with a total plant capacity of around 4,300 MW, was approximately 18 per cent. By 2035, no less than 60 per cent of the country's electricity is expected to be produced from renewable energy, increasing to 70 per cent by 2050. As Chile increases its reliance on weather variable renewable energy sources, there will be an increased requirement for fast-response, cost-competitive backup power sources such as the power plants in Prime Energía's portfolio to stabilise the electricity grid.

New framework agreement

MTU UK has been supplying engines to Sunseeker for many years, installed in Sunseeker models from 60ft (approx. 20 metres) to 155ft (approx. 47 metres).

MTU and British luxury yacht manufacturer Sunseeker International have agreed a new framework agreement for the supply of MTU Series 2000 and 4000 engines for its 86Y, 95Y, 116Y and 131Y range of yachts and for future yacht series. Under the terms of the agreement, new technologies and systems solutions that MTU launch on the market during the contractual period until the end of 2020 are also to be included.

"We intend to continue the successful working relationship we have enjoyed with MTU in the course of the last 18 years," said Michael Straughan, Chief Operating Officer of Sunseeker International, "and that is why we have now signed a new framework agreement. In MTU, we have an exceptional partner for the introduction of innovative technologies and can look forward to a very positive future together."

#Gas

Fueling the energy transition with gas

The term 'energy transition' has spread rapidly around the world and is now a widely recognized concept not only in Germany but in the USA too. Discussions about an energy transition usually refer to electricity generated using renewable resources such as solar, wind and water power. We should not forget, however, that combustible gas containing methane also plays an essential role in that transition. Gas can be used to generate electricity – either continuously or in order to balance out fluctuations in the supply network. It can also be used to power waterborne vessels – and it does the job with considerably less sulfur, soot, nitrogen oxide and CO_2 emissions than diesel engines. Electrolysis also means that gas can be made even greener still. With superfluous gas gained from renewable sources of energy, electrolysis can be used to generate renewable methane allowing gas to function as a power battery and to speed up the energy transition at the same time.

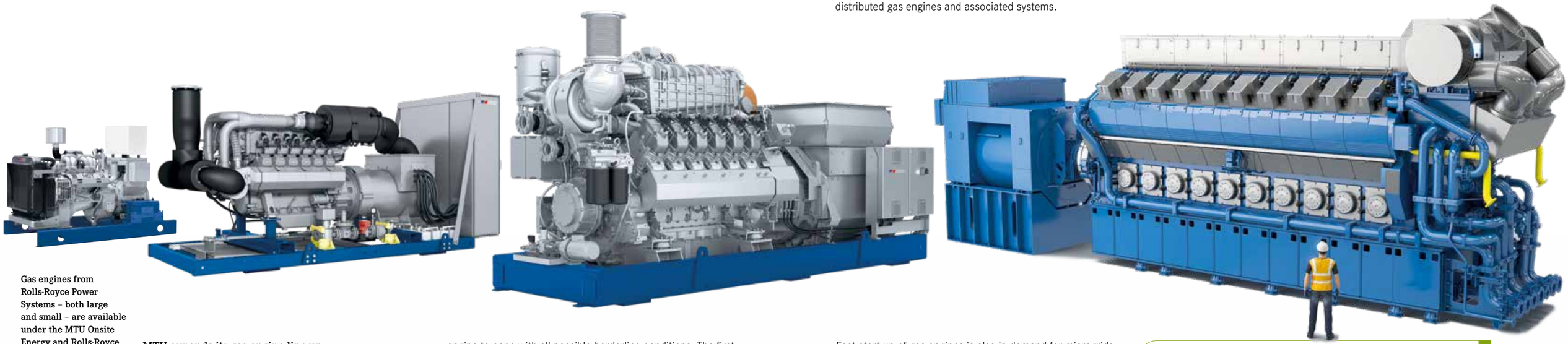
Energy

#Gas

It's a gas!

Gas is booming worldwide. More and more countries have access to gas and are using it to generate green power efficiently. The trend is towards smaller, distributed, digitally interlinked gas-fired plants that generate power locally where it is needed – as an alternative to large conventional power plants. In addition, natural gas power plants can compensate for grid fluctuations and thus make a significant contribution to grid stabilization. Gas-fired CHP plants also play a key role in what are now known as microgrids. In order to have the right system solution for every customer application, MTU is constantly expanding its gas engine portfolio.

Until a few years ago, gas was a straightforward business, with huge pipelines necessary for transport. Then, a wildcard came into play. Liquefied natural gas, or LNG for short, can also be transported by sea over great distances to where it is needed, and fed into local pipelines. New LNG terminals are being built across the world to store gas awaiting onward distribution. Added to this is the fact that more and more countries are gaining access to gas because they are developing their own gas fields. Mozambique, Bangladesh, Myanmar and Israel are just some of these.



Gas engines from Rolls-Royce Power Systems – both large and small – are available under the MTU Onsite Energy and Rolls-Royce brands: the small ones are emergency gensets from Mankato in the US with outputs of 30 to 400 kilowatts, the large ones are Rolls-Royce gas gensets with outputs of up to 12 megawatts. Located inbetween are MTU Onsite Energy gas gensets with outputs of 200 to 2,500 kilowatts electric.

MTU expands its gas engine line-up

"We want to offer suitable solutions to all our customers," explained Andreas Görtz, the man responsible for MTU's distributed powergen systems business. MTU Onsite Energy gas gensets with an output range of 30 to 400 kilowatts of electricity for emergency power applications are being built in Mankato, USA. In Germany, high-speed gas systems for continuous use in the 200 to 2,500 kilowatt range are produced at the company's Augsburg facility. And in Bergen, Norway, Rolls-Royce gas gensets with outputs of 1.4 to 11.6 megawatts are built based on the company's medium-speed engines. But now, the portfolio is really set to grow. "Over the next few years we're looking to expand our power range offering and develop new system solutions," said Görtz. "We will then be able to offer customers end-to-end gas systems delivering anywhere between 30 kilowatts to 11.6 megawatts," he added, with an eye to the future.

One world: one gas system

One engine that is already expanding this portfolio is a new model in the company's line-up of proven Series 4000 gas engines: the L64FNER. F stands for 'fifty hertz', N for 'natural gas', and ER for 'epsilon reduced', i.e. a lower compression ratio. The engine can be used anywhere – at extremes of temperature and air humidity as well as at high altitudes.

With conventional engines, high humidity means moist air is drawn into the combustion chamber, potentially leading to corrosion. To prevent this, MTU engineers have raised the temperature of the cooling water in the mixture cooler so that the fuel-air mixture is warmer and therefore does not condense. In order to be able to test the engine in real-life conditions, MTU has built a test stand at its Augsburg facility to simulate tropical conditions. Engineers can, say, raise the humidity of the intake air in order to be able to adjust the engine to cope with all possible borderline conditions. The first engine models are presently about to go into full production, with development staff now working to get the others ready.

120-second start-ups: load-balancing power courtesy of gas systems

In parallel, MTU developers are also working on another variant of the Series 4000 gas engine: an engine with faster start-up capabilities. This one can reach its full output of 130 kilowatts per cylinder within 120 seconds, whereas previous MTU gas engines took much longer to get there. This quick-start capability opens up a wider range of applications for the gas engine. Increasing use of renewables – such as solar and wind – in power generation may make it greener, but there are also major fluctuations in the power grids that have to be compensated for. For example: When everyone turns on their lights at 7am and switches on the coffee machine, or when big industrial users get going, suddenly a lot of electricity is needed all at once. The trouble is, at this time of the morning there is often little wind blowing, and not much in the way of sunshine, so renewables are not reliable or stable enough to cover all the demand. This is where gas systems come in. They can be relied upon to be available and supply electricity safely and predictably until sufficient wind or solar power comes on stream. Many European countries have special programs for this 'balancing power' used in grid stabilization, setting out how quickly gas-fired power plants must be able to bring their balancing power online.

Hitherto, this was a job mainly undertaken by diesel engines, but that is currently changing. "Gas is cheaper and more CO_2-neutral than diesel, which is why more and more customers are opting for it," explained Andreas Görtz. Moreover, in most cases, the governments' national balancing power programs stipulate that balancing power must be generated using distributed gas engines and associated systems.

Gas engines for emergency power generation

However, Michael Koliwer, chief engineer for MTU's power generation systems, knows there is still room for improvement. "We still want to be faster," he said. Indeed, he also has another vision in mind: combined with a rotating mass and the new MTU battery containers, gas engines could then also be used to generate emergency power supplies.

So is gas about to beat diesel at its own game? "Certainly not," said Andreas Görtz. The really important thing to him is that MTU, as a solution provider, is able to offer every customer the ideal engine for each application. "And we're well on our way down that road," he added.

Fast start-up of gas engines is also in demand for microgrids. Microgrids team gas engines with renewable energy sources such as wind and solar power plants, adding battery storage systems and an overarching control system. The controller uses parameters specified by the consumer to calculate which power sources are used at which time in order to deliver power either to consumers or to a battery bank such as the MTU 'battery container'.

The dynamics and the resultant dearth of new applications for gas engines initially presented developers with a challenge, since engines had previously been designed for prolonged periods of operation, with start-up time not terribly critical. A new piece of software now ensures, among other things, that the turbocharger can provide the engine with the required fuel-air mixture much more quickly. A special priming pump also supplies the engine with oil at all relevant bearing points within a very short period of time. Together with further improvements in the start-up procedure, the developers have achieved their goal: The engine reaches full power within anywhere up to 120 seconds.

MEMO

The RRPS gas engine line-up

Rolls-Royce Power Systems offers various gas engine gensets under its MTU Onsite Energy and Rolls-Royce brands.

Engines from other suppliers	30 – 400 kWe (for 60 Hz only)
MTU Series 400	220 – 400 kWe
MTU Series 4000	800 – 2,500 kWe
Rolls-Royce	1.4 – 11.6 MWe

Words: Lucie Maluck
Pictures: MTU, Bergen Engines

To find out more, contact:
Andreas Reisacher
andreas.reisacher@mtu-online.com
Tel. +49 821 7480-2202

What will be in **tomorrow's tanks?**

Hydrogen, methane, methanol, DME, OME, synthetic diesel – when it comes to combustible fuels we are spoilt for choice. But which of them offers the best prospects for the future? R&D specialists at MTU are currently working on a range of projects to establish which fuels are most economical and efficient and what the best engines for them will be.

The energy released when a fuel is combusted can be converted into drive power. The fuels of the future and their chemical characteristics are exciting questions in engine technology.

Renewable methane for **marine applications**

Headed jointly by MTU and the DVGW (German Technical and Scientific Association for Gas & Water) Research Unit at the Engler-Bunte Institute of the Karlsruhe Institute for Technology, the 'MethQuest Project' currently involves 27 partners who are working on methods of generating fuels from renewable energy sources for use in engines. One area of their activities involves MTU researchers looking at two new engine concepts for marine applications. "We are working on two different projects. One focuses on an Otto engine concept and the other involves a flexible-fuel engine concept with direct injection," explained project leader, Dr Manuel Boog.

Otto engines have been around for a long time because it is easy to burn gas in Otto engines. The problem with this concept is that the gas is never entirely combusted and uncombusted methane can escape. The phenomenon is called 'methane slip'. "Methane is more damaging to the atmosphere than CO_2. Consequently, the potential of gas engines to achieve substantial reductions in greenhouse gases is not exploited," said Boog. One of the aims of the MethQuest Project is to develop a 'methane oxicat' (catalytic converter) to neutralize the negative effects of methane. The problem is that methane requires high temperatures for oxidation in the exhaust gas tract. In the engine, such temperatures are only present upstream of the turbocharger turbine. The catalytic converter therefore needs to be located here. However, this has a seriously negative influence on engine dynamics and MTU engineers are therefore working on an electrically assisted turbocharging concept that will counteract these disadvantages.

Gas engine with no methane slip

The second gas-engine concept under investigation for marine applications, the flexible-fuel, direct-injection concept, involves the development of a completely new combustion process. "Here, just like in a diesel engine, the air is first compressed in the combustion chamber. The main source of energy, gas, is then introduced and a small quantity of diesel is injected at the same time to ignite the gas," explained Boog. The advantage of this process is that the gas is almost entirely combusted and the unwanted occurrence of methane slip remains negligible. "We have already demonstrated that this combustion process works in a different, publicly sponsored project called "FlexDI"," added Boog. The concept has the additional benefit that the combustion process involved also means that methanol can be used to power engines without complications. One of the challenges remaining to be solved here is the development of a suitable high-pressure gas system as the injection concept means the gas needs to be highly compressed and heated for injection.

"We will run trials with both concepts and the pressurized gas supply system and will then decide which is the most promising for further development in the context of the drive system overall," said Boog. Both concepts aim to produce engines that deliver comparable power and performance to diesels but with a significant reduction in environmentally negative emissions.

Which **fuels** represent **the future?**

The latest report from the Intergovernmental Panel on Climate Change (IPCC) reads like a final warning: This late in the day, climate targets agreed upon internationally are going to prove very difficult to achieve and they will only be achievable at all if we act with unswerving determination. And those determined efforts must include the decision to say goodbye to fossil fuels like coal, oil and natural gas because burning these resources has been a major factor in the increase of greenhouse gases in our atmosphere.

A future fueled by hydrogen and methane?

The future lies with synthetically produced fuels that offer clean and climate-neutral combustion overall. One such fuel is hydrogen that can be produced from renewable energy sources using electricity. It can either be used directly or synthesized into methane using carbon dioxide. The big advantage of hydrogen and of synthetic methane is that they produce no, or at least significantly less, polluting emissions during combustion. In addition, they can also be produced using electricity generated by wind power and photovoltaic installations. However, if not used immediately, this power has so far proved difficult to store. This explains why, on especially sunny or windy days, there is often more power available than consumers need. An alternative way of storing that energy is to use it to produce fuel – that means transforming electrical energy into energy for powering engines.

«I believe that we will rely on a range of different fuels in future. Sole reliance on a single fuel is not a likely option.»

Dr Peter Riegger, MTU Director Research & Technology

Methanol: An alternative to LNG

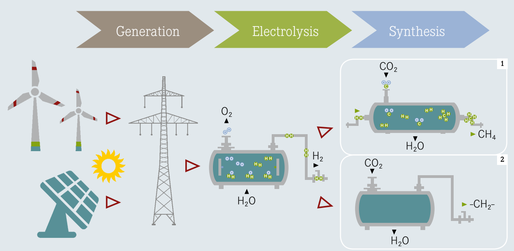
Engine specialists have taken this line of thought a step further because methanol can be derived from methane and, as a liquid fuel, it is much easier to store. The benefits of methanol are especially obvious for marine applications. "Until now, LNG (liquefied natural gas) has been seen as a possible future fuel for ships. But LNG can only be transported and stored in high-pressure tanks or at temperatures of minus 164°. It is difficult to maintain such temperatures over longer periods of time," explained Dr Peter Riegger, MTU Director Research & Technology. Methanol could provide an alternative because, unlike LNG, it does not require complex infrastructural storage facilities and can therefore be integrated much more easily in marine vessels.

But methanol is not the ultimate step in the ongoing fuel development process. Methanol can be used to produce diesel alternatives such as DME and OME. These are synthetic fuels that could also be used in slightly modified diesel engines. In this context, Fischer-Tropsch synthesis processes can also be used to synthetically produce diesel fuel that fully conforms to standards.

The main question currently facing MTU specialists is which fuel is most likely to prove most economic and most energy-efficient in the future. "If we use hydrogen to produce methane or methanol, then we lose energy in the process," said Riegger. "Despite that, methanol could still prove to be the fuel of the future, particularly in marine applications because it is relatively simple to store and handle," he added. However, the situation looks rather different when it comes to stationary engines for generating electricity. Here, infrastructure is by no means as important because existing natural gas grids can be extended. Consequently, for this scenario, hydrogen presents a more promising alternative.

"I believe that we will rely on a range of different fuels in future. Sole reliance on a single fuel is not a likely option," said Riegger.

How does electric power become fuel?



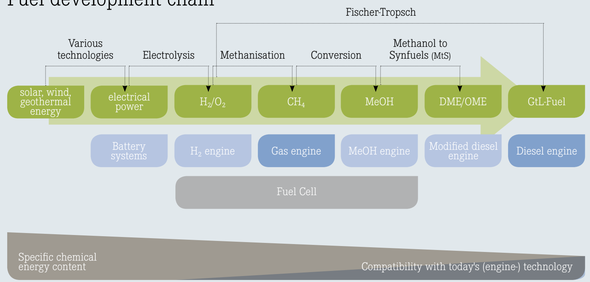
1 **Power-to-Gas (PtG) e.g. H_2, EE-Methan, ...**

2 **Power-to-Liquid (PtL) e.g. DME, OME, Methanol, E Diesel, ...**

Source: German Federal Environmental Agency

Electric power generated from renewable sources of energy is available in excess when there is plenty of sunshine or plenty of wind but this superfluous energy cannot be directly utilized. One possibility for storing it involves the electrolysis of water to generate hydrogen. Only oxygen is generated in addition to hydrogen. The hydrogen generated can either be used directly or CO_2 can be introduced in a process of synthesis to produce gaseous fuels such as methane (power-to-gas) or liquid fuels such as methanol, DME or OME (power-to-liquid).

Fuel development chain



Renewable electric power generated from solar or wind power can be used to generate hydrogen (H_2). In subsequent stages, this can be further processed to produce, for example, methane (CH_4), methanol (MeOH), alternative fuels such as DME/OME (dimethyl ether / polyoxymethylene dimethyl ether) or diesel-type fuels (P-to-L). As the process chain advances, energy is released in the form of usable thermal energy that is then no longer available for drive purposes. Compatibility with diesel / gas engines increases as the process stages advance. In the initial stages of the process chain, fuel cells represent an alternative to combustion engines.

Hydrogen and the **combustion engine**

In the context of the 'MethPower' research project, MTU is also working on the development of engine concepts for stationary gas engines. "We want to establish which engine will allow us to generate electricity most efficiently," said Project Leader Dr. Michael Thoma. This project also involves the development of two engine concepts that will ultimately be compared with each other. One is a hydrogen-powered engine. "Hydrogen can be produced from superfluous electric power by electrolysis. It therefore makes sense to use it in our engines," explained Thoma. Just as with the natural gas engine, the MethPower Project employs the combustion of hydrogen using the Otto process. A spark plug is used to ignite the hydrogen/air mixture. However, hydrogen burns much faster than natural gas. "That is a challenge we will deal with over the coming months," declared Thoma.

Power-to-gas

Together with its other aims, the MethPower Project is working on the continued development of an engine that will run on natural gas and/or methane. "The MTU portfolio has included these engines for quite some time. What we are now seeking is to incorporate the engine in a system based on fuel generation and exhaust gas utilization," said Thoma. The CO_2 generated during combustion could be extracted directly from the engine exhaust and this CO_2 could be used to produce new methane. "The idea is particularly interesting in the context of microgrids," said Thoma. In this configuration, the gas engine is integrated in a network of power generators and storage devices. The network could be extended by including a 'power-to-gas' installation that would reduce the battery requirement. "The power-to-gas installation would work in conjunction with a gas storage vessel, like a large battery. It would use renewable electrical energy to produce methane that could be converted back to electricity if required whenever no sun or no wind is available," explained Thoma.

At the end of the process, R&D specialists will have to decide which concept will provide the best balance between energy generation and energy consumption and thus deliver the greatest efficiency.

Solutions for the future

Synthetic fuels and new engine concepts all have one thing in common – they all make a major contribution to minimizing CO_2 emissions and promoting moves toward the more responsible use of energy. "That is our aim and our duty as a responsible company. We aim to develop drive solutions for the future and we commit to playing an active role in that process," said Dr Peter Riegger in summary.

Words: Lucie Mallick
Pictures: Adobe Stock

To find out more, contact:
Dr Peter Riegger
peter.riegger@mtu-online.com
Tel. +49 7541 90-6995

Single-cylinder research

MTU research specialists use single-cylinder test stands to conduct trials involving cutting-edge technologies. "What happens here will happen later in every engine cylinder. That is why it is not worth building a complete engine with up to 20 cylinders to run tests during the initial stages of research and development," said Dr Peter Riegger. MTU Director Research & Technology. The MTU location in Magdeburg has four such test stands set up for a wide range of fuels, and the company's Friedrichshafen location has four further test stands designed for tests with diesel.

The gas pioneer

For years, the maritime industry has been working hard to clean things up and minimize vessel emissions. Sustainable solutions are particularly in demand in sensitive ecosystems such as the Wadden Sea, which was declared a World Heritage Site in 2009. Dutch shipping company Doeksen is setting a good example by deploying two single-fuel, natural-gas-powered ferries in 2019, which will cut pollutant emissions by a significant margin. They will be powered by MTU's new mobile 16-cylinder single-fuel gas engines.

Paul Melles, Managing Director of Dutch shipping company Doeksen, is looking forward to two new ferries powered by MTU gas engines.

The view from Paul Melles' office window has evoked a lot of envy down the years with its panorama of the Wadden Sea which runs between the northern Dutch coast and the broad, sandy islands that guard it. On a good day, the island of Terschelling stretches out to the right, with its smaller counterpart, Vlieland, to the left. Halfway between them is a sandbank called Griend, which doubles up as a bird sanctuary. In front of his large picture window, the managing director of Dutch shipping company Doeksen, which operates ferry services to the two islands from its base in Harlingen, has set up a large tripod, and when he needs to take a moment out from his busy work schedule, he puts his eye to the telescope and surveys the scene laid out in front of him. “It's a great place to switch off,” says the 58-year-old. “And there's always something to see.”

Soon Melles' gaze will be resting every day on something he has been looking forward to for some time now: two new ferries the company ordered from the Strategic Marine shipyard in Vietnam back in April 2016. The company currently operates three ferries bringing both vehicles and passengers to the islands, plus two fast ferries, one catamaran for RoRo freight vehicles only, and a water taxi. The *MS Midsland*, one of the older ferries, is soon to be retired. “We were looking for a new ferry concept that was both sustainable and innovative,” explains Melles, who used to be a seaman himself, later becoming Technical manager, and finally Managing Director of Doeksen in 2001. After a strategic study, those responsible decided to build two smaller catamarans instead of one large ferry, which not only makes the timetable more flexible, allowing more services to and from Terschelling, but ultimately also boosting efficiency, thereby also lowering operating cost. The study recommended single fuel LNG (liquefied natural gas) as the fuel of choice with the option of using BIO LNG or LBG (Liquified Bio Gas) in the future.

The new ferries will arrive in Harlingen in spring 2019.

1 The ferries were built at the Strategic Marine shipyard in Vietnam.

2 At the heart of each ferry are two MTU gas engines with outputs of 1,492 kilowatts each.

Newly-developed gas engine wins the day

It is of great concern to the managing director to minimize Doeksen's environmental footprint. "Climate change cannot be denied, and we simply have to do something," he stresses. "We have a wonderful landscape and seascape right here on our doorsteps – the Wadden Sea is a world natural heritage site. Most passengers who use our ferries come here because of the beautiful natural surroundings – the lovely islands and the clean, fresh sea air." The shipping company plies these routes frequently, so it has to take care of the environment. "This is what sets us apart. And it's why we should treat this place with care," Melles continues. This includes things like using green electricity at all company sites, heating the terminal in Harlingen with a CO_2-neutral pellet heating system, and reducing emissions given off by the fleet. Above all, however, it was clear from the outset that the two new vessels had to be equipped with environmentally-friendly propulsion systems. "Full Electric propulsion was not an option for us yet, given the battery systems currently available on the market," explains Melles. "Terschelling is 21 nautical miles from Harlingen, meaning we would have to recharge the batteries after every trip. We just don't have that amount of time, and it's why LNG is the optimum solution for us right now."

> «Even though this is a completely new product that has yet to establish itself, we are entirely convinced of the merits of the new gas engine.» Paul Melles, Managing Director Doeksen

Compared with the gas oil normally used on our ships, liquefied natural gas has the advantage of giving off significantly less in the way of hazardous emissions. In fact, carbon dioxide emissions can be reduced by up to 10 percent, and nitrous oxides by up to 90 percent, while zero amounts of sulfur are given off, and particulate emissions are eliminated almost entirely. "When we started designing our new ferries, we knew MTU was developing a gas engine," says the Doeksen boss. "But it wasn't quite ready, and the word was, initially, that it probably wouldn't be finished in time." As a result, the company's managers began looking around for other options – while, at the same time, MTU techies in Friedrichshafen were pressing ahead with the development work. Their rapid progress and enthusiasm finally tipped the scales for Paul Melles: "We know MTU as a top-notch manufacturer of high-performance diesel engines that are extremely reliable. And even though this is a completely new product that has yet to establish itself, we are entirely convinced of the merits of the new gas engine."

Challenges along the way

The few LNG-powered vessels already operating in other waters are mostly equipped with dual-fuel engines – meaning they can operate on diesel or gas as required. "This is an option we don't need, because we have a fixed route from A to B and back again," says Melles. "MTU has developed the first single-fuel high-speed gas engine that can directly and mechanically drive a fixed pitch propeller, with transient acceleration capabilities comparable to that of a typical high-speed diesel engine. On top of all the enthusiasm and zeal of those involved, this was a major argument that really won our hearts and minds." And so, Doeksen's two new 70-meter-long catamarans are to be fitted with MTU's new 16-cylinder Series 4000 gas engines, each with an output of 1,492 kilowatts, and will soon be ferrying up to 600 passengers and 64 cars across the Wadden Sea at speeds of up to 14 knots.

In the meantime, it was not quite clear whether the pilot project would actually be brought to a successful conclusion. Initially, certification of the mobile gas engine by Lloyd's Register, the maritime classification society, took longer than originally thought. "That was a major challenge," says Melles, "but I have to take my hat off to MTU. They managed to speed up the processes and obtain certification in good time. That really was a great job." Subsequently, the shipyard in Vietnam ran into financial difficulties and stopped work on the new ferries for three months. For Melles, who visited the site every six weeks or so during the entire construction period to check progress, this was a tough, exhausting time – until the banks finally agreed on new project financing, allowing it to continue.

The anticipation rises

It is now planned that the new additions to the fleet, the *Willem Barentsz* and the *Willem de Vlamingh* – named after two Frisian seafaring explorers – will arrive in Harlingen in spring 2019 and then, following commissioning and various tests, will commence regular ferry services in September 2019, by which time the necessary infrastructure changes to Harlingen harbor will have been completed, including a new overnight berth for an additional vessel, minor adjustments to the pier for safe berthing and bunkering for weekly refueling. Paul Melles can hardly wait to take delivery of the new cats: "I've been working on this since the very beginning, these are my babies. It's really exciting to see something that started out as an idea being taken through to implementation. We've waited so long for this, and now it's all coming to fruition."

> «MTU has developed the first single-fuel high-speed gas engine that can directly and mechanically drive a fixed pitch propeller, with transient acceleration capabilities comparable to that of a typical high-speed diesel engine. That won our hearts and minds.» Paul Melles, Managing Director, Doeksen

For the 58-year-old, who lives 33 kilometers from his workplace and uses an Opel Ampera with an electric motor for his daily commute, there is no way he is going to miss the maiden voyage. As a former seafarer, he likes to be out on the water whenever he can – at weekends and during vacation time, preferably on his own sailboat. And during working hours, he will continue his efforts to keep the Doeksen fleet as clean as possible. He sees LNG very much as a transitional fuel. "This is a good, practical transition fuel, but a fossil fuel nonetheless, and thus finite," he says definitively. At some point there will be working solutions for electric propulsion, perhaps also for hydrogen drive systems. But until then, he's got another idea: bio-LNG – gas produced and liquefied in biogas plants. "This would enable another major reduction in CO_2 emissions," he says. "There is the potential to obtain this in the area. And that's what we're looking into now: that's our next goal."

Words: Anne-Katrin Wehrmann
Pictures: Doeksen

To find out more, contact:
Phil Kordic, phil.kordic@mtu-online.com
Tel. +49 7541 90-3692

The root plant using **plant roots**

In Thailand's agricultural heartland, biogas plants make more than just good business sense. In the villages of Nakhon Ratchasima they are also eliminating an annoying odor problem.

The winter months used to be anything but pleasant in the area surrounding Prayut Vitthayanukorn's factory in the Thai province of Nakhon Ratchasima. The entrepreneur can remember this very well. Strong north winds used to blow over its waste water reservoir, taking the stench of sulfur straight into the neighboring communities. “We used to get a lot of complaints about it,” says Prayut. He shows us old pictures of the plant: a murky, foaming liquid can be seen. For him, it was clear that this could not be allowed to continue.

Environmental protection takes priority

His home country of Thailand is an emerging country, and economic growth is still often at the expense of the natural surroundings. But Prayut chose to take a different approach: He made environmental protection a company priority. In fact, he turned his waste water problem into a tangible benefit – with the help of a biogas plant. He was one of the first industrialists in the region to use this technology, but now many are following his lead. That said, southeast Asia's second-largest economy still has some catching up to do in terms of promoting biogas plants.

Prayut's factory is located in northeastern Thailand – an agricultural area seldom visited by tourists. He makes his money from an agricultural product: he processes the root tubers of the cassava plant, also known as manioc, into starch. His company, General Starch Limited (GSL), supplies this powder Native Tapioca and Modified Tapioca Starch by the ton, mainly abroad, generating over 100 million dollars in sales per year. The starch ends up in foods such as sauces and doughs, and also in industrial products like paper and plasterboard.

In the early morning, it is still dark as the trucks of the cassava farmers line up outside the factory gates. The trucks are colorfully painted and loaded to the brim with many tons of root material. One of these vehicles belongs to Chainart Rakkaserm. The 55-year-old's field is ten kilometers away. Today, he's bringing in 7 metric tons. He drives his truck onto a weighbridge to determine the exact weight of the produce and then parks on a kind of lifting platform that tilts diagonally downwards at the push of a button, tipping the load out and allowing it to fall down a shaft and onto a conveyor belt. This is where the cassava roots begin their industrial odyssey – the factory processes around 800,000 tons each year.

Biogas from waste water

Before the roots are turned into powder, they go into a washing machine. The milky waste water flows through pipework into an outdoor basin where it is covered by a black tarpaulin and, from a distance, is reminiscent of a giant air mattress. Beneath the dome of the tarpaulin, microorganisms turn the contaminated water into biomethane. The gas is extracted and cleaned – and is then used as the factory's most important source of energy. The plant produces around 90,000 to 100,000 cubic meters of biogas every day, half of which is used by Prayut to heat steam boilers. The steam is used to dry the roots – a process which used to require oil to be burned. The use of biogas not only helps to protect the environment by reducing the use of fossil fuels, it also pays off financially: Prayut says he saves a quarter of a million baht per day, somewhere around 6,000 euros.

But that's not all. The 67-year-old co-founder of the company, who created GSL in the early 90s together with some business partners, lets his son Kamolpat demonstrate the heart of the plant: General Starch produces its own electricity in the factory's own power plant. Kamolpat, who will one day take over the running of the family business,

Colorfully painted trucks piled full with cassava roots on the way to Prayut Vitthayanukorn's factory.

1 Under the black tarpaulin, micro-organisms process the wastewater from the cleaning of the cassava tubers into biomethane.
2 This is used to generate heat and power using an MTU Onsite Energy CHP plant.
3 Prayut Vitthayanukorn is the founder of the company General Starch Limited which processes root tubers of the cassava plant into starch.
4 Cassava plants grow mainly in northern Thailand.
5 The bulb of the plant is processed into starch and exported worldwide.

hands out earplugs to his visitors before further ado, because things are about to get really loud: behind the soundproof door are four MTU Series 4000 engines. The control room is decorated with Buddhist drawings and prayer flowers intended to bring luck to a challenging task. The engines are indeed very audible, and run thousands of hours a year without interruption.

Electricity accounts for 20% of production costs

General Starch Limited's products are in global demand, with 80% exported over the globe, where cassava powder is used as a cheaper alternative to potato starch. The comparatively poor potato harvest in Europe this year will further increase demand for this alternative product from Thailand. As a result, Prayut's factory is running 24/7, powered largely by electricity, which normally accounts for anywhere up to 20 percent of production costs, according to Prayut. His in-house power plant helps him reduce this cost by a significant amount. The MTU engines, which have been in operation since 2016, give him a capacity of 8 megawatts – power which help GSL reduce drawing the electricity (approximately 80%) from the national grid. According to the company, this reduces the factory's electricity bill by around 160,000 euros per month. Prayut is also able to use the waste heat given off by the engines to power a cooling system.

Company power plants like this are now more common in the province of Nakhon Ratchasima, which is usually referred to by its inhabitants as Korat. This is partly down to the efforts of Thai engineer Prasit Pornsaksit who supplies energy-efficient turnkey solutions to companies in his home country through his company MSM. “In Thai agriculture, biogas plants are now in demand in many places,” said Prasit. “But it is cassava processing that produces by far the most waste water. This means it is also possible to use biogas to fuel engines with power outputs in the 1.5 to 2.0 megawatt range.”

One of Prasit's customers in the cassava trade now has eight MTU engines in operation. They generate a lot more electricity than the factory needs for its own requirements. The owner sells the surplus to the power company and receives feed-in tariff payments in return. “This is a worthwhile business,” said Prasit. However, the model is not currently available to other companies. The Thai government has suspended additional purchases of renewable energy for the time being. The reason given by the authorities was that they feared electricity prices would otherwise rise. Previously, suppliers of renewable energy received a generous premium on top of the market price as an incentive.

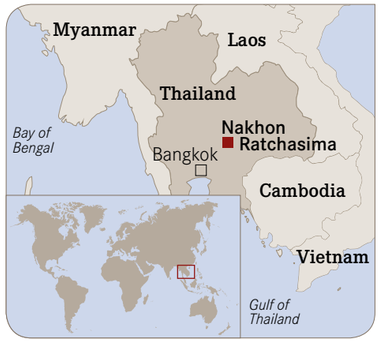
Prasit is in favor of foregoing the subsidy but reopening the power grids. He reckons that electricity generated from biogas would pay for itself even without the subsidies. Rolling these out could go a long way towards helping protect the environment.

He can see great opportunities for biogas, for example, in Krabi in southern Thailand, one of the most popular holiday destinations in southeast Asia due to its superb beaches and idyllic islands. But local residents fear that the unique natural surroundings of the area could be damaged by a coal-fired power station currently being planned. The project to supply the much-visited region with urgently needed power has been a matter of dispute for some years now. Biogas could go a long way towards alleviating the power bottleneck. Krabi may not have any cassava factories, but there is no shortage of palm oil mills. “Their waste water is an excellent source of biogas,” enthused Prasit.

Economic benefits secondary

In Korat, Prayut describes biogas as indispensable for the success of his business. However, he emphasizes: “The economic benefits were secondary to me from the very beginning. My primary concern was to find a solution to the environmental problems.” The positive contribution that General Starch Limited wants to make in the region can also be seen in a field near Chainart's farm. The cleaned and treated waste water from the Cassava factory is sprayed onto the ground in thin jets from plastic pipes. It is used here to irrigate a General Starch reforestation project. Banana trees and herbs are already growing here. There are also plans for a small mushroom farm. Prayut ultimately wants the site to become a kind of natural supermarket for local residents, where everyone can help themselves free of charge.

From Chainart's point of view, the factory's reputation has been greatly enhanced by the owner's initiatives. He says it gives him much more than a reliable living, but that the negative aspects of starch production have also now been eliminated. “In the past, the winter stench literally got up our noses,” he recalls. “But fortunately, that's now a thing of the past.”



Words: Mathias Peer, Nakhon Ratchasima
Pictures: Mathias Peer

To find out more, contact:
Norbert Maier
norbert.maier@mtu-online.com
Tel. +49 821 7480-2396

1

3

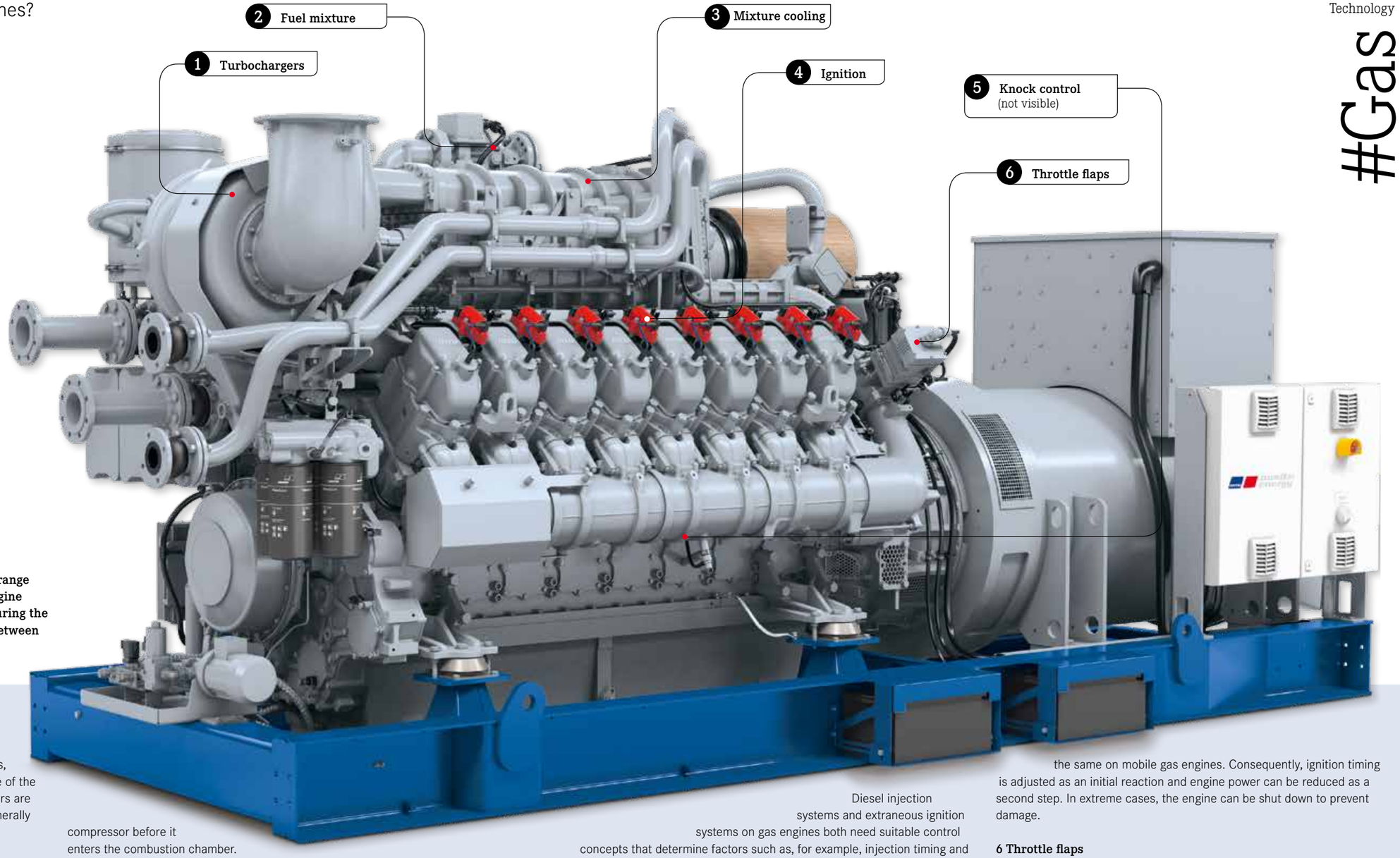
1 and 4 MTU Onsite Energy's combined heat and power plants enable GSL to save 160,000 euros a month in electricity costs. GSL also uses the waste heat to supply the cooling system with power. **2** Chainart Rakkaserm cultivates cassava tubers and supplies them to GSL. **3** The treated wastewater from the GLS cassava factory is used for irrigation on a reforestation project run by General Starch.

2

4

The small **diffe-rences**

Gas engines are increasingly taking the place of diesels in a range of areas including off-highway applications. Both types of engine deliver similar performance but gas engines emit less CO_2 during the combustion process. So, what precisely are the differences between the two? This overview provides some answers.



1 Turbochargers
The turbochargers used on diesel engines and mobile gas engines are virtually identical. They both feed the engine with the air (and, therefore, oxygen) it needs for combustion. On stationary gas units, the turbocharger has to process both the air and the entire volume of the gas/air mixture and in stationary genset applications, turbochargers are optimized to match full-load conditions because these engines generally operate at full-load.

2 Fuel mixture
In diesel engines, air is sucked into the combustion chamber where it is compressed to levels that raise its temperature as high as 700 C. Injectors then introduce diesel fuel that ignites in the hot air. In stationary gas engines, the air is mixed with fuel gas before it passes through the turbocharger and mixture cooler to the combustion chamber. Mobile gas engines utilize multi-point injection systems. Here, air is routed to the cylinder and gas is introduced just before it enters the combustion chamber. This means that the volume of gas can be flexibly regulated depending on the power required.

3 Mixture cooling
Diesel engines have charge-air coolers that cool the air heated in the compressor before it enters the combustion chamber.
On gas engines, this function is performed by the mixture cooler. Depending on the application in question, the gas/air mixture is cooled in two stages to around 50° C to 60° C before passing on to the combustion chamber. The thermal energy extracted during the cooling process can be decoupled from the system and fed into a heating system, for example.

4 Ignition
The most obvious difference between diesel and gas engines can be found in the ignition systems. Diesels are self-igniting engines in which high levels of compression cause the diesel/air mixture to ignite spontaneously. Like gasoline-fueled engines, gas engines use a spark generated by a spark plug to ignite the gas/air mixture (the illustration shows the spark plug connectors and cables leading to the cylinder head cover).

5 Knock control
Diesel fuels adhere to precise specifications and deliver highly consistent levels of quality for efficient engine set-up. However, the constituents in gaseous fuels vary and this affects combustion. For example, different gases have different methane numbers (similar to octane ratings for gasoline) that indicate the proportional mixture of an equivalent fuel consisting of methane and hydrogen. If the methane number is too low, inefficient spark ignition and other uncontrolled combustion processes can occur in the combustion chamber. These generate ‘engine knock’ and gas engines need to be controlled to deal with the phenomenon. Stationary gas engines use vibration sensors to identify knock whilst pressure sensors do the same on mobile gas engines. Consequently, ignition timing is adjusted as an initial reaction and engine power can be reduced as a second step. In extreme cases, the engine can be shut down to prevent damage.

Diesel injection systems and extraneous ignition systems on gas engines both need suitable control concepts that determine factors such as, for example, injection timing and duration (diesels) or ignition point and energy (gas).

6 Throttle flaps
On both diesels and mobile gas units the formation of the fuel mixture is controlled flexibly for each ignition sequence in order to influence engine power. Stationary gas engines use a premixed gas/air mixture that remains constant and engine power is influenced by using throttle flaps to regulate the flow of the mixture. Mobile gas engines also have throttle flaps but these regulate the pressure of the mixture entering the cylinder.

Words: Lucie Maluck; Pictures: MTU

To find out more, contact:
Dr. Christoph Heinz, christoph.heinz@mtu-online.com
Tel. +49 7541 90-4661

Did you know?

The term **GAS** was coined by **J.B. VAN HELMONT** (1577–1644), a Flemish chemist. It derives from the Greek word for **CHAOS.**

Stars are spherical bodies of gas. But inside, it's incredibly hot, many millions of degrees Celsius. Their **IMMENSE HEAT** makes the gas glow white hot – shining like a light bulb, just many magnitudes brighter.

HUMAN DIGESTIVE GASES consist of around 65% nitrogen, 20% hydrogen, 10% carbon dioxide, 3% methane and 2% oxygen. Hydrogen sulphide, mercaptans and indoles are responsible for the characteristic odor. With normal digestion, the bacteria produce a volume of somewhere around one liter of trouser turbulence per day.

HYDROGEN is the lightest, most common and most explosive gas in the world. **RADON** is the heaviest known gas with an atomic mass of 222. It is 220 times heavier than the lightest gas, hydrogen.

Dangerous gas mixtures in mining are known as **whitedamp.** These gas mixtures are formed by mixing breathing air with gases which are harmful to humans either because of their toxic properties or because they displace the air's oxygen. Miners used to use **canaries** as a means of detection. When the air was low in oxygen or laden with poisonous gases, the canary responded immediately by interrupting its song and falling off its perch, prompting the miners to escape to safety.

NATURAL GAS is a combustible gas mixture made up of 75 to 99% **METHANE** (CH_4). The other components are **ETHANE** (C_2H_6), **PROPANE** (C_3H_8), **BUTANE** (C_4H_{10}) and **ETHENE** (C_2H_4).

The gas mixture found in the earth's atmosphere is referred to as air. **DRY AIR** is mainly made up of the two gases **NITROGEN** (approx. 78.08% by volume) and **OXYGEN** (approx. 20.95% by volume). It also contains **ARGON** (0.93% by volume), **CARBON DIOXIDE** (0.04 % by volume) and traces of other gases.

At temperatures of around **-192 °C** under normal atmospheric pressure, our air would **turn to liquid.**

Gas engines **knock** when the methane number of the gas is too low. This happens when parts of the compressed gas-air mixture explode before it has been fully combusted by the spark from the igniter.

5,500 meters
above sea level

36,000 HOURS

MTU 16V 4000 C11 engines only come up for overhaul every 36,000 hours.

164 COUNTRIES

Specialist technicians provide support for **MTU engines** in 164 countries worldwide.

180 MILLION

37,000 Series 4000 engines have demonstrated their reliability over more than **180 million** hours of operation.

The Julong Copper Mine in Tibet is located at an altitude of 5,500 meters, making it the highest in the world.

The haul trucks made by Chinese construction machinery manufacturer XCMG can accept payloads weighing up to 110 metric tons.

Alexander Richter (pictured right, beside Ren Chuan Wei) found it difficult to breathe in the rare mountain air.

5,500 meters above mean sea level, in the world's highest mine, MTU engines deliver full power for haul trucks.

Anyone who has ever experienced high-altitude mountain conditions knows the feeling – the air is thin and breathing is difficult. The amount of oxygen in the air falls with every extra meter. Even at around 3,000 meters, the conditions may not worry experienced mountain hikers but those used to life at lower altitudes can already start to experience breathing difficulties at 1,500 meters. However, the high-altitude environment at the Julong Copper Mine in Tibet presents no such problems for the MTU Series 2000 engines currently driving haul trucks from Chinese manufacturers XCMG and NHL. And the remarkable thing is that they operate with absolutely no reduction in power.

At altitude, oxygen is rare

"We already knew our engines are ideal for operation at altitude and we specifically set them up to ensure they deliver 100 percent power under those conditions. Nevertheless, we were still surprised by just how much better they are than other engines operating in the mine," reported MTU applications engineer Alexander Richter who conducted commissioning operations in Tibet for haul trucks from both manufacturers. "I had much bigger problems acclimatizing to the environment myself," he admitted. For one thing, he had to work more slowly. "Right from the start, I had to get used to working at a more measured pace." The rarefied air is low in oxygen and the human body constantly demands a readily available supply. As a result, people working at altitude have to breathe faster and tend to be constantly out of breath.

Richter and his Asian coworkers used a Landcruiser for their daily commute between the Tibetan regional capital Lhasa and the mine. At first, the 1,700 meter difference in altitude proved a challenge for them all, causing constant headaches. "We found it hard to understand how the Chinese and Tibetan mineworkers were able to work in the thin air at that altitude." But eventually they got used to the conditions. "After three days, we were acclimatized and working was no longer as difficult," said Richter.

Fit for operation at altitude thanks to two-stage turbocharging

Unlike the crew, the MTU engines were on top form from the start – thanks to cutting-edge engine technology. Smart coordination between two-stage turbocharging, exhaust gas recirculation and high-pressure common rail injection systems meant that the engines met Tier 4 emissions regulations without any need for exhaust gas aftertreatment. "The engines' two-stage turbocharging technology is the crucial factor for operation at altitude," explained Richter. Unlike older units with single-stage turbocharging, the latest engines utilize two-stage technology to ensure adequate compression and air-feed for combustion. The air first undergoes precompression in a low-pressure turbocharger

Repowering increases performance

MTU engines are also in operation at high altitudes in Peru. Located at a height of 4,500 meters, the Antamina Copper Mine operates a fleet of 92 Komatsu haul trucks several of which have been repowered with MTU Series 4000 engines over recent years. For a while, the mine was undecided about risking the switch because MTU engines are longer than the original units and that meant extending the vehicle chassis. However, after the first trucks were repowered in September 2016, subsequent trials showed that the engines delivered 96 percent availability, fuel costs dropped and the trucks traveled faster. The company repowered further trucks this year. "Antamina is a great example because it is an extreme case," declared Scott Woodruff, MTU Mining Director, "but that is nowhere near the end of the story. Today, there is no way companies can fail to consider the possible benefits that non-conventional repowering can bring."

Komatsu haul trucks were retro-fitted with MTU engines at the Antamina Copper Mine in Peru, which lies at an altitude of 4,500 meters.

8% FUEL SAVINGS

Powered by MTU Series 4000 engines, Komatsu 830E haul trucks use 8% less fuel than before. That means an annual saving of US$ 30,000 per truck for the operator.

With their new MTU engines, the Chinese NHL trucks are now much faster uphill, making the mine more productive.

MTU engineers commissioning engines at the Tibetan Julong Copper Mine.

ZERO REQUIREMENT FOR EXHAUST GAS AFTERTREATMENT

MTU engines generating more than 750 PS meet current emissions regulations without the need for any exhaust gas aftertreatment system.

before it is cooled and then further compressed in a high-pressure turbocharger prior to final cooling.

As a result, the air is so highly compressed that when it reaches the combustion chamber it again contains all the oxygen the engine needs for combustion. Consequently, no hardware modifications to the engine were needed and MTU engineers simply adjusted the engine control using the 'virtual engine' facility. Every MTU engine model has a computerized thermodynamic simulation model validated on the basis of measured data from test stand trials. This enables MTU developers to pre-calculate and program the correct engine control settings for every conceivable set of environmental conditions. These then only need to undergo on-site testing and fine adjustment.

The engines' environmental pressure sensors are especially vital for operation at altitude. These measure barometric pressure to allow the engine control system to select exactly the right performance maps that relate to operation at the appropriate altitude.

No practice-based data available

"In theory, we knew it would work," said Richter. Nevertheless, commissioning in Tibet was still a tense process. "Here on site, the engines have to operate at 5,500 meters and we had no relevant practice-based data for that," he explained. At these altitudes, engines from our competitors have had problems with serious power loss and heavy smoke. Engine damage is frequent. That does not happen with MTU engines."

First engines performed well

In their very first tests in Tibet a year ago, MTU engines demonstrated their outstanding altitude-performance capability. Chinese construction machine manufacturer XCMG tested and commissioned a vehicle powered by a 16-cylinder MTU Series 2000 engine. The company has already ordered a further ten engines (due for delivery at the start of 2019) and for the last few months another Chinese construction machinery company NHL has been running altitude trials in Tibet involving two MTU Type 12V 2000 C66 mining engines. "So far, the results have been very impressive," said Richter.

Haul trucks from both companies are now in full, regular daily operation carrying 90 and 110 ton loads of copper and spoil at the mine. Their crews may quickly get out of breath in the thin air but their MTU engines definitely do not. Capable of traveling uphill significantly faster than other trucks at the mine, the MTU-powered vehicles deliver greater productivity than other haul trucks at the site.

Words: Lucie Maluck
Pictures: Alexander Richter, Eugene Tay

To find out more, contact:
Alexander Richter
alexander.richter@mtu-online.com
Tel. +49 7541 90-3935

EXTREME

MTU engines must be built to withstand the toughest conditions.

MEMO

MTU engines tested to extremes

Mining at minus 60 degrees

At the Aikhal Diamond Mine in Siberia, specially adapted MTU Series 4000 engines operate reliably at temperatures of minus 60°C. Because the Polar diesel used in the region has a kerosene content of 60 percent and is therefore significantly thinner than standard winter diesels, MTU designed the injectors so they are not destroyed by the ultra-low viscosity fuel. Louvers in front of the radiator prevent engine temperature from dropping too low and are always closed during idling when it gets too cold. The engine control system automatically adjusts fuel quantity and injection timing to suit the air temperature and in addition to primary injection, a pre-injection system is activated for start-up depending on the ambient temperature.

Emergency power when the earth trembles

And what happens during earthquakes? Obviously, emergency power gensets must not fail on any account and so developers at MTU Onsite Energy in Mankato, USA, simulated an earthquake under test conditions. Mounted on a test stand, a genset powered by a 3,250 kW MTU Series 4000 engine was exposed to a severe quake. The result: Both before and (more importantly) after the quake, the genset continued to run and to do what it was designed to do under such conditions – namely, generate electricity. Successful completion of the test means the genset fulfills the requirements of the International Building Code (IBC).

Continuing to run upside-down

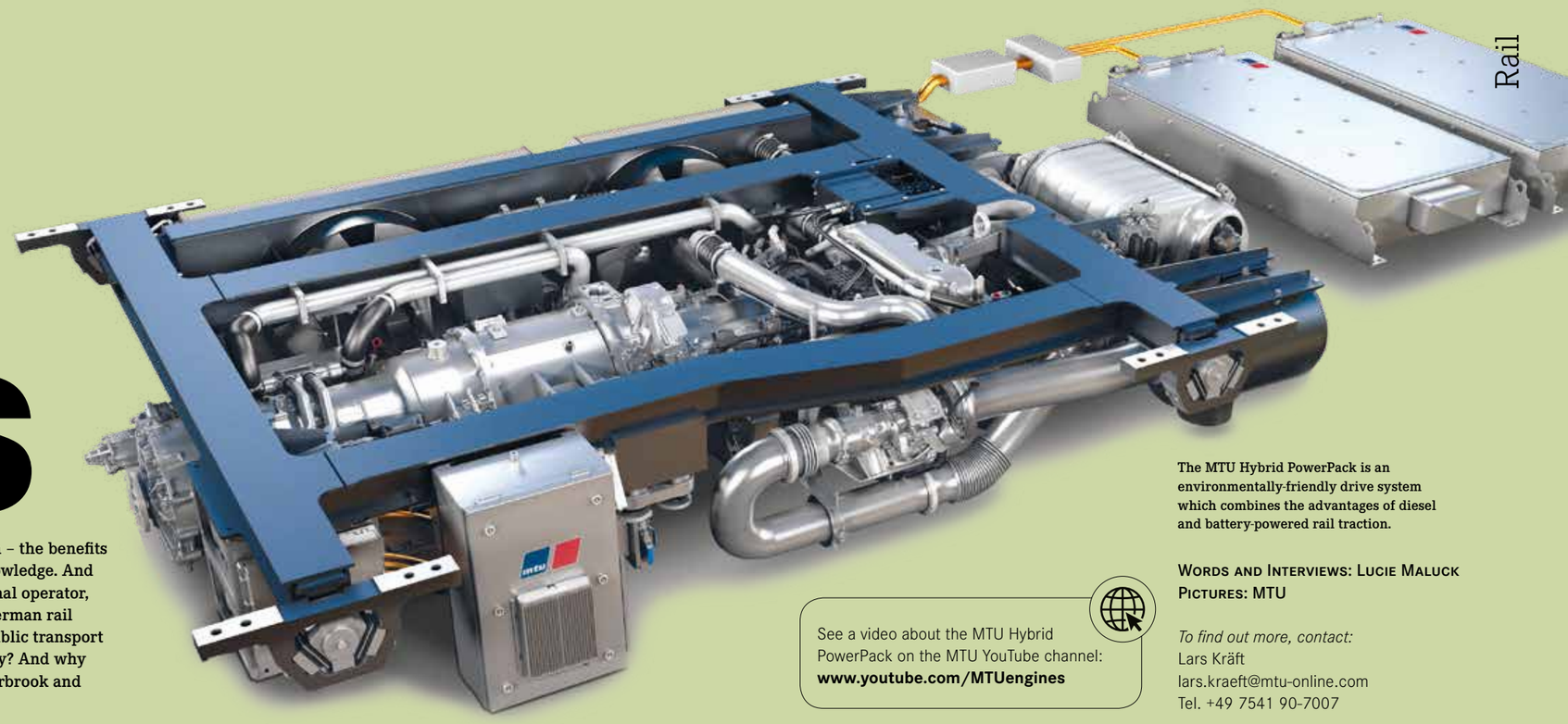
To prevent lifeboats turning into death traps themselves, they have to maintain propulsion even in the most extreme circumstances. The engines have to keep on running even when the boat turns turtle and remains upside down for a few seconds. The danger is that as the vessel rotates, engine oil may enter the cylinders via the crankcase ventilation system and cause uncontrolled combustion that destroys the engines. MTU engineers have therefore incorporated a valve in the crankcase ventilation that closes in response to the vessel's angle to prevent any escape of oil. The valve opens again automatically when the boat returns to an upright position.

In Siberia, MTU engines power haul trucks at temperatures of -60°C.

Lifeboat engines have to turn the vessels on their own axis without stalling.

The Time has come for hybrids

Bigger fuel savings, lower pollutant emissions, quieter trains and faster acceleration – the benefits of PowerPacks – MTU's hybrid traction systems for railcars – have long been common knowledge. And now the product has established itself on the market – with a vengeance. Irish Rail, the national operator, and UK rail leasing companies Porterbrook and Alpha Trains have signed letters of intent. Likewise German rail operator Abellio in partnership with rail solutions provider Alstom and the Saxony-Anhalt regional public transport service. The signings took place at Innotrans, the world's largest rail trade fair, in September 2018. Why? And why now? Jim Meade, CEO of Irish Rail, Dr Nikutta, Managing Director of Alstom, Mary Grant, CEO of Porterbrook and Lars Kräft, MTU Vice President, Industrial Business Sales, explain all.



The MTU Hybrid PowerPack is an environmentally-friendly drive system which combines the advantages of diesel and battery-powered rail traction.

See a video about the MTU Hybrid PowerPack on the MTU YouTube channel: **www.youtube.com/MTUengines**

Words and Interviews: Lucie Maluck
Pictures: MTU

To find out more, contact:
Lars Kräft
lars.kraeft@mtu-online.com
Tel. +49 7541 90-7007

«We're making **fuel savings of 30 percent»**

Jim Meade, CEO of Irish Rail

We're constantly looking for ways to reduce cost. Hybrid traction is something we've had in mind for a while, but only now has the fleet replacement program presented us with the opportunity of making it all happen. We're going to start by retrofitting nine of our Class 22000 railcars with MTU Hybrid PowerPacks. MTU has simulated this in advance, and we are set to save over 30 percent of diesel consumption. And as fuel costs are such a key factor for us, this argument is a pretty important one. At the same time, we're also going to reduce our CO_2 footprint, which is also important to us. For our customers – the passengers – the main benefit of hybrid traction is that trains are much quieter when they run electrically. If the initial systems prove their worth, we want to fit them to all 235 of our railcars. Although the Irish rail network will be electrified in parallel, I see this as a very long-term project. By the time this is completed, we will already have saved a lot of money with hybrid and reduced pollutant emissions.

«Hybrid will help us alleviate **air pollution** in cities»

Dr. Jörg Nikutta, Managing Director of Alstom

Especially in view of the diesel debate, hybrid traction is a very exciting issue for us. Our customers, rail operators, can now pull into railway stations with zero emissions under electric traction, and help reduce air pollution in our cities. For me, hybrid traction is currently a very sensible solution in engineering terms, and will enable robust diesel technology to remain in service for a long time to come. Looking ahead, though, I can foresee trains without internal combustion engines, so hybrid is more of a bridging technology, I think. But this particular bridge is a long one, and diesel-powered trains will probably still be around in 30 years' time. After that, I can foresee exciting technologies, such as hydrogen, that will enable trains to run with zero emissions even without overhead contact lines.

«We want to reduce the **carbon footprint of our fleets»**

Mary Grant, CEO of Porterbrook

This is one of several initiatives that Porterbrook is undertaking to address the challenge, set by the Department for Transport, of removing diesel-only trains from the UK rail network by 2040. We are committed to reducing the emissions and carbon footprint of our existing diesel-powered fleets. We hope our investment in this trial of MTU Hybrid PowerPacks will enable us to offer wider fleet fitment of this technology, so that our customers can reduce both emissions and operating costs, as well as improve air quality along urban corridors. Hybrid trains have the added benefit of operating with very little sound when using battery power, offering additional benefits to the railway's near neighbours.

«**We've managed** to get our customers excited **about hybrid traction»**

Lars Kräft, MTU Vice President, Industrial Business Sales

After a long development lead-time, our Hybrid PowerPacks are now absolutely ready for market. Why now? Firstly, the technology has been refined considerably over the past few years – I am thinking in particular of battery technology. Today we can offer significantly more capacity and have made great progress in integrating the battery with the traction system. There is also ever-increasing demand in society for environmentally-friendly drive technologies. Added to this – and I am particularly proud of this – is the fact that we've managed to get our customers really enthusiastic about our hybrid traction solutions. Everyone was delighted to be part of this innovative project. Demand is now really high, and I am convinced that Hybrid PowerPacks will soon become the standard traction systems for railcars on non-electrified lines.

MTU Go! products in use on hydrofoils operated by Navigazione Laghi

Going app!

Powered by MTU, the hydrofoils operated by Navigazione Laghi ply the waters of northern Italy's greatest lakes: Lake Garda, Lake Maggiore and Lake Como. Thanks to MTU's digital Go! products, the operator now knows at all times how the engines are doing, and exactly where the vessels are on their routes.

Italian company Navigazione Laghi transports almost 10 million passengers and around 700,000 vehicles a year, including numerous tourists and commuters, on northern Italy's three big lakes: Lake Garda, Lake Maggiore and Lake Como. The company has an impressive total of 100 MTU engines in service on its 88 vessels, including some spare units. Engine and vessel uptime is extremely important to the ferry operator, which is why it recently equipped the first hydrofoils in its fleet with MTU data loggers. Now vessel positions and engine operating data can be monitored on mobile cell phones running the MTU Go! Act app, and on laptops with the MTU Go! Manage software, making it possible to respond even more quickly to any alarms that might occur.


1


2


3

1 Captain Flavio Pitigliani takes the hydrofoil *Galileo Galilei* on four day trips totaling almost ten operating hours per day. Navigazione Laghi's Executive Director on Lake Garda, Franze Piunti (right), relies on digital monitoring. **2** One of the means of transport on the lake very popular among tourists are the hydrofoils operated by Navigazione Laghi. **3** "Using MTU Go! Manage we obtain data on consumption and engine condition, and can analyze it for purposes of preventive maintenance and problem solving," explains Navigazione Laghi's General Manager, Alessandro Acquafredda.

Peschiera, Garda and Sirmione – place names reminiscent of carefree holidays, and southern Europe. They are all located beside Lake Garda which, with its mild Mediterranean climate, is a popular holiday destination right into the Fall. One of the means of transport on the lake very popular among tourists are the hydrofoils operated by Navigazione Laghi. At 8:25 in the morning, the first tourists board the hydrofoil *Galileo Galilei* at the landing stage in Peschiera. After casting off, the vessel's Series 2000 engines are powered up to 2,250 revolutions per minute, and a surge of torque lifts the vessel clear of the water as it moves over the waves.

The operating company Navigazione Laghi is now putting its trust in MTU's digital credentials, using the Go! platform developed by MTU's in-house Digital Solutions unit. "There are two aspects that make MTU Go! Manage an extremely attractive proposition for us: we obtain data on consumption and engine condition, and can analyze it for purposes of preventive maintenance and problem solving," explains Navigazione Laghi's General Manager, Alessandro Acquafredda.


1


2


3

1 Recently a data logger has been installed on the vessel's bridge. **2** Data on consumption and the condition of the engines aboard the hydrofoils can be viewed on a laptop or mobile cellphone. **3** Stefano Gibelli, Technical Manager of MTU Italia (right), showing Paolo Mazzucchelli, Technical Manager of Navigazione Laghi, how he can now use the MTU Go! Act on his cell phone to view operating data on the hydrofoil's Series 2000 engine.

No more logbooks

Engine data is sent from the data logger to the platform, where it is processed by MTU analysts. It can then be used both by the customer and by MTU experts. For Navigazione Laghi, this means that when the hydrofoil gets under way, the company's General Manager on Lake Garda, Franze Piunti, can immediately see if there are any error messages on his mobile phone using the Go! Act app. "The use of Go! products is a win-win situation for us. We and customers are better informed on the state of usage of their MTU engines. The service app also reduces engine damage and provides faster solutions," says Stefano Gibelli, Technical Director at MTU Italia.

“In the past, fault messages were entered into the logbook by the skipper, and that's where they stayed. Now we can respond even to a small message and thus avoid major damage or even engine failure,” says Paolo Mazzucchelli, Technical Director at Navigazione Laghi. “We wanted the data link to give us better control over what happens to the boat.” This is understandable when you consider, for example, that an injector takes three hours to replace, and that replacing an entire engine can be a two-week job. To optimize diagnostics, the platform also contains maintenance schedules and the engine's technical documentation.

The hydrofoil carries up to 160 passengers per day on each of its four routes. The first journey of the day takes us parallel to the western edge of the lake and terminates – a good two hours and ten stops later – in Limone, an area known for its oranges and citrus fruits. But after a mere five-minute break the ship is off again on the next leg of its journey to Riva del Garda in the far north of the lake. The lake here is edged with 2,000-metre-high mountains. The southern shore of this, the largest Italian lake, forms the gateway to the south due to its location in the lowlands of northern Italy. The tight schedule means quite a workload for the two Series 2000 V12 engines which each supply the hydrofoil with anywhere up to 1,080 kilowatts of power. A full ten engine-hours later, the ferry's daily workload draws to a close as its last passengers disembark at the landing stage in Peschiera at 6:55 p.m. and bid farewell to vessel and crew.

1 MTU Italia Service Technician Matia Lupi (left) supervised installation of the new Series 2000 engines at the beginning of September. The data link was installed as part of the repowering project. “This allows us to respond even to a minor error message and thereby preclude engine failures before they occur,” says Paolo Mazzucchelli, Technical Director of Navigazione Laghi (right).
2 Stefano Gibelli, Technical Manager of MTU Italia (links), showing Paolo Mazzucchelli how he can now use the MTU Go! Manage on his laptop.

Connecting vessels across the world
MTU has tailored the presentation of the data specifically to the user's application: Operators of generating sets, for example, can see how much electricity a plant is currently producing. MTU's digital services are used not just by ship operators, but also by rail and power generation customers. “We train our customers how to evaluate the information they see in Go! Act and Go! Manage to best effect, and how to use the apps,” adds Hubert Maier from the Digital Solutions unit. New Go! product users are added every week, as over 600 data loggers are installed by the end of the year.

Repowering – complete with data links
Navigazione Laghi is also planning digital link-ups for more of its vessels: the repowering of all eight hydrofoils is being put out to tender. “Our hydrofoils have had MTU engines for decades now, including the Series 331 and 396,” says Director General Alessandro Acquafredda, pointing to the long-standing relationship with MTU. 88 of the company's 98 vessels ply the lakes powered by MTU engines – hydrofoils, passenger ferries and car ferries. “By repowering five hydrofoils on the northern Italian lakes with two engines each, we have opted for cleaner, more fuel-efficient and more powerful MTU engines.” After all, fewer nitrous oxide emissions and lower fuel consumption not only pay off for the ferry operator, but also convey a prominent message to passengers and local residents. The MTU Series 2000 is IMO-II certified and does not require SCR technology to meet the emission limits which apply today. Also, the new engines offer much-improved response characteristics and have more torque than their predecessors. This makes it easier to lift the vessel into hydrofoil mode, and not only makes the skipper's work easier but also gives tourists the incomparable feeling of gliding over Lake Garda until late October.

MEMO

How hydrofoils work

As speed through the water increases, a hydrofoil's hull is lifted clear of the water by the dynamic lift produced by its underwater foils, thereby reducing displacement and friction resistance. To do this, the vessel's engines are mounted at an angle of 20 degrees.

Powered by MTU, the hydrofoils operated by Navigazione Laghi ply the waters of northern Italy's greatest lakes: Lake Garda, Lake Maggiore and Lake Como. Thanks to MTU's digital Go! products, the operator now knows at all times how the engines are doing, and exactly where the vessels are on their routes.

WORDS: ANIKA EMMERICH; PICTURES: ROBERT HACK, NAVIGAZIONE LAGHI

To find out more, contact:
Stefano Gibelli, stefano.gibelli@mtu-online.com, Tel. +39 187 1588-400

You can watch a MTU video about the use of digital tools on the MTU YouTube channel: **www.youtube.com/mtuengines**

Expansion of engine parts and tools

→*How do we...*

Charles Patterson heats a tool holder to allow the tool to be fitted.

1

2

...make parts larger?

Michelangelo once said, "Every block of stone has a statue inside it and it is the task of the sculptor to discover it." The process of machining is similar, a blend of art and science, as Travis Blystone, Machining Supervisor at the MTU Aiken plant, explains, "In machining, we start with a raw casting of metal – basically, a blank slate. Then, we carefully remove, form and cut it down to make a finished product."

In addition to the assembly of Series 2000, Series 4000 and Series 883 engines for MTU America, the MTU Aiken plant is home to the machining of cylinder heads, flywheel housings and other large components. To ensure world-class performance, a machinist must cut every piece of metal with extreme precision. That means the machinist's tools must be precise as well. When a tool is of the highest quality and accuracy, it doesn't vibrate - and cutting is smooth and fast. Metal is formed perfectly, while reducing manufacturing times.

Expanding and contracting

At Aiken's tooling department, machinists use the expansion and contraction properties of metal to ensure a powerful grip between tool holder and tool shank. "The tool holder itself is heated up to 300-550°F, depending on the size of the holder. This makes it expand just enough to allow the correlating drill or reamer to be inserted. Then a cooling collar filled with circulating water is placed over the tool holder," says Blystone. "When it cools, the metal contracts and holds the tool with great force."

1 **Tarrance Johnson inserts a chilled valve seat into a heated (and thus expanded) cylinder head.**

2 **The tool holders pictured right are heated to allow the tool to be fitted with precision. Once this is done, it is chilled. The fitting can then only be undone by heating the tool holder once more.**

The process is quick and simple and requires no special screws, torque wrenches, collets or hand tools. Normally a collet, a segmented band put around the shaft, is tightened by hand to grip the tool. However, if not torqued correctly, the tool could slip or move, damaging the part. This results in wasted costs and time. "The entire process takes about 40 seconds. It heats it up very quick, and it cools it down just as quick to a point where that tool's ready. You just pick it up by the shank and you're ready to go," says Blystone.

Ensuring the perfect fit

Across the plant on the cylinder head line, heating is also used to make parts larger. During the washing process, the cylinder head is cleaned to remove particles. At the same time, it expands in size slightly, since it is submerged in a washing chamber heated up to 140°F (60°C). After it's removed, the head opens up just enough to fit the valve guides and valve seats, which have been chilled to make them smaller. It results in a tighter fit than made possible by hand, and eliminates the need for power assistance tools or muscle power, which can cause damage.

It all results in perfectly formed metal components that work seamlessly together. Michelangelo would be proud.

Words: Chuck Mahnken
Pictures: Amber Chafin

To find out more, contact:
Travis Blystone
travis.blystone@mtu-online.com
Tel. +1 803 232-6060

Things our editors have been impressed by

Afterthoughts

In the digital age
I'd never traveled on a hydrofoil – not until the end of September, that is. That's when our photographer Robert, cameraman Rolf and I all went down to Lake Garda where we were able to experience this incredible piece of marine technology and also the magic of a beautiful late summer in Italy. Being on a hydrofoil is just like floating above the water. And, of course, I'm pleased to report that it was the latest generation of MTU Series 2000 engines that was responsible for raising the vessel and its 160 passengers above the water. Whilst I spent most of the crossing wielding my cell phone to capture the panoramic views, the guy right next to me, who happened to be Paolo Mazzucchelli, Technical Director of Navigazione Laghi, was using his to check on the status of the engines working away in the hull. To do it, he used MTU's new digital product, the 'Go!-Platform'.

Anika Emmerich saw MTU's digital products in action during a trip on Lake Garda.

Anne-Katrin Wehrmann met Paul Melles, CEO of Dutch shipping concern Doeksen.

Preserving a World Heritage Site
It's good to see a relatively small shipping company like Rederij Doeksen taking the trouble to seek and find ways of playing its part in preserving the Wadden Sea World Heritage Site. Whilst Doeksen's two new ferries with their environmentally friendly MTU engines may well be the most obvious illustration of its efforts – the company also pays close attention to the finer details. For example the plastic cutlery and cups used in the catering areas are being replaced as far as possible by metal utensils and china tableware. And a CO_2-neutral heating system has been installed in the ferry terminal. It's good to know that people in positions of responsibility, like company CEO Paul Melles, are well aware that they have a fantastic area of natural beauty right on their doorstep and that it's important to take good care of it.

Talking of... ...gas

Turn to pages 13 to 35 to find out more about gas, the main theme of this issue. And for an interesting fact about pit canaries, go to page 35.

IMPRINT

Imprint

MTU Report The magazine of the MTU and MTU Onsite Energy brands **PUBLISHED BY** Rolls-Royce Power Systems AG; Publisher's representative: Wolfgang Boller **EDITOR IN CHIEF** Lucie Maluck, e-mail: lucie.maluck@rrpower-systems.com, Tel. +49 7541 90-2566 **EDITORS** Rolf Behrens, Anika Emmerich, Chuck Mahnken, Tim Metcalfe, Mathias Peer, Silke Rockenstein, Anne-Katrin Wehrmann **EDITORS' ADDRESS** Rolls-Royce Power Systems AG, Maybachplatz 1, 88045 Friedrichshafen **DESIGN AND PRODUCTION** Designmanufaktur|Ries, 88214 Ravensburg **LITHOGRAPHIE** Wagner Medien UG, 88690 Uhldingen-Mühlhofen **PRINTED BY** Vorarlberger Verlagsanstalt GmbH, A-6850 Dornbirn ISSN-Nr. 09 42-82 59, Reproduction only under indication of the source.

Please forward a copy. **WEBSITE ADDRESS** www.mtureport.com

ONLINE

Follow us online

Find more news and information about MTU in our webmag www.mtu-report.de and our newsletter MTU eReport by registering at www.mtureport.de/newsletter. You can also read more about technical innovations, exhibitions and product applications on our social media channels.