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A piece of the zero-emission puzzle

WIND-ASSISTED PROPULSION

LNG & methane slip

Progress made, but still an issue

A leader in offshore

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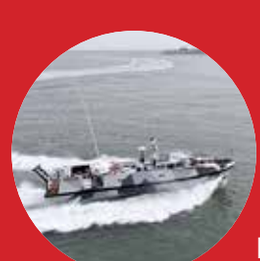

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First Expeditionary Survey Boat for the Dutch navy

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Wind assisted ship propulsion (WASP) could be one of the pieces to solve shipping's zero-emission puzzle. Read all about it in our WASP special.

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Om de CO_2-emissies met gemiddeld veertig procent per schip te laten dalen in 2030 en met vijftig procent voor de sector als geheel in 2050, moeten reders nu knopen doorhakken over de bouw van emissieloze schepen.

40 | LNG fuel and methane slip

The main non-economic reasons for using LNG are reduced emissions. Yet, it also has a disadvantage: the so-called methane slip, the leaking of methane, a very strong greenhouse gas (GHG).

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Cover: de Frisian Sea is hier begin maart benoorden Texel gefotografeerd onderweg naar Noorwegen. De unit levert een brandstofbesparing van zes à acht procent.

The comeback of sails in shipping

A couple of years ago practically nobody, except for some die-hard enthusiasts, would have believed that big cargo ships would use sails again for their propulsion. But with the necessity to ban climate-threatening fossil fuels from shipping, the use of sails, perhaps not as a main energy source, but at least as wind assisted ship propulsion (WASP), becomes more realistic by the day.

The Dutch Ventifoil sails of eConowind that can be very easily stowed away in containers on deck are an example of a very simple solution for the application of WASP on existing and newbuild shortsea ships. The models for much bigger cargo ships like the Swedish Oceanbird project of a car carrier of 32,000 displacement look wonderful. And in the UK, Windship Technologies recently presented its "Tesla of the seas", a fairly realistic model of a mid-size cargo liner with sails and solar technology. We are also anxiously awaiting more news on the plans our own Guus van de Bles of Conoship presented to the IMO in the autumn of 2019 for a zero-emission ship with WASP. And perhaps the beautiful model of Dykstra Naval Architects for a 11,850 deadweight cargo ship with sails already launched six years ago can now become reality. Of course, we must not forget that this year, the Dutch yard Neptune Marine in Hardinxveld-Giessendam will start building a 121-metre ship with WASP for a French shipowner that intends to transport Ariane rockets with this Canopée from Europe to French Guyana.
In Scandinavia and Germany in particular, shipowners re-discovered the almost 100 years old technology of the Flettner rotor that is now placed on several newbuild ro-ro ferries, tankers and other cargo ships. In short, using wind power for sailing is not just a hobby anymore, but serious business that can help make shipping more sustainable and with that can improve the image of shipping, very important in the ever fiercer battle against climate change. So plenty of reasons for the editorial staff of SWZ|Maritime to take a closer look at these interesting developments. Our colleague Sander Klos, a skipper himself that regularly sails the replica of the Hanze-Kogge of Kampen on the North Sea and into the Baltic, took on the coordination of this WASP special. And in such a special one cannot do without a contribution of Mr. WASP himself, Gavin Allwright, Secretary-general of the International Windship Association.

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SWZ'S EDITORS

150 million for sustainable recovery of Dutch mobility sectors

The Dutch R&D scheme for the mobility sectors maritime, automotive and aviation has become a reality. On Friday 12 March, the Dutch Cabinet approved a 150-million euro scheme for innovative projects in these sectors. The scheme is intended as co-financing for companies that want to invest in research and development, linked to sustainability and digitisation. For the maritime sector, this means that knowledge development will lead to new innovations and bring about the next step in the transition towards zero-emission shipping.
Investment in the development and application of new technologies is necessary to ensure that Dutch ships will be able to significantly reduce their emissions in the foreseeable future and operate emission-free to comply with national and international targets. The technical challenges in the maritime energy transition are huge; the required power for ships is very high (many megawatts) and the necessary range very large (many days to weeks). The systems for this kind of high power are still under development and use fuels that are not yet widely available or applicable.
This is why the sector has drawn up the Master Plan under the banner of maritime umbrella organisation Nederland Maritiem Land. The purpose of this Plan is to make a sustainable difference after the corona crisis. In concrete terms, this means that cooperation throughout the chain will be addressed with the government playing a role as launching customer. The various development paths must lead to cost-effective and workable solutions that will be applied to at least thirty emission-free and digital ships in 2030 and will then be widely adopted by the market itself. The budget made available by the government for the R&D scheme makes it possible for companies to actually start developing new techniques. Think for example of offshore and work ships, passenger ships, dry cargo ships, tankers and of course ships for the government fleet.

Allseas' President Edward Heerema receives OTC heritage award

Allseas' President Edward Heerema, who launched the company in 1985, will receive the OTC Heritage award for his 'long-term continuous, distinguished service in management and leadership of offshore installation for the deepwater industry'.
Heerema's contributions to offshore marine construction have been paramount. He developed the concept of dynamically positioned subsea pipelay with the introduction of Allseas' first vessel Lorelay. In 2007, Solitaire set the world record for ultra-deepwater advanced pipeline installation in 9100 ft (2774 m) of water.

In 2016, Heerema realised a lifetime vision with the launch of the world's largest construction vessel Pioneering Spirit (photo Allseas).

Moreover, in 2016, Heerema realised a lifetime vision with the launch of the world's largest construction vessel Pioneering Spirit, which has since revolutionised the offshore heavy lift industry through single-lift technology.

The Offshore Technology Conference (OTC) is where energy professionals meet to exchange ideas and opinions to advance scientific and technical knowledge for offshore resources and environmental matters.

Support for Damen's ballast water treatment solution InvaSave

The EU and Dutch government have joined Damen Shipyards to fight invasive species in ballast water. Climate Investor Two has approved an investment that could amount to 24.5 million euros to support the lease of Damen's portable ballast water treatment solution InvaSave to customers in Africa, Asia, and Latin America.
Climate Investor Two (CI2) is a financing facility mandated to invest in water, sanitation and ocean infrastructure projects in emerging economies. It enjoys cornerstone support from the EU and the Dutch Fund for Climate and Development (DFCD). The consortium that manages the 160 million DFCD also includes the World Wide Fund for Nature Netherlands (WWF-NL), Netherlands Development Organisation (SNV) and Entrepreneurial Development Bank (FMO).
Climate Fund Managers, the manager of CI2, as well as the DFCD, is pleased to announce the signing of this Development Funding Agreement of 2.8 million euros to finance the start of this project with Damen Financial Services, the newly founded department within Damen Shipyards Group.
The Damen containerised ballast water treatment system InvaSave offers a port-based solution to ships ill-equipped to treat their ballast water or wishing to supplement their existing treatment capabilities to meet higher standards. In addition, the system is currently the only one to be certified by the International Maritime Organization,

The Damen containerised ballast water treatment system InvaSave offers a port-based solution to ships ill-equipped to treat their ballast water.

which is responsible for the implementation of the BWM convention. During the commercial phase, it is estimated that the systems will treat up to 36,000 m^3 of ballast water per day.

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Scrubbers paid off in 2020

According to BIMCO, the world's largest organisation for shipowners and charterers, 47 per cent of the bulk carriers delivered in 2020 were fitted with a scrubber. The organisation highlights a correlation where the bigger a ship's fuel consumption, the more likely a shipowner will opt for a SO_x scrubber over the use of very low sulphur fuels (VLSFOs) to comply with the sulphur cap. And in 2020, these scrubbers have paid off. BIMCO states that in 2020, the average spot market earnings for a scrubber-fitted Capesize bulker (125,000 to 220,000 DWT) exceeded those of ships without a scrubber fitted by almost USD 3000 per day. *(BIMCO)*

Wireless fire detection

The Italian company Microdata Due designs fire detection systems for cruise and naval vessels. A recent product, currently under testing, is a wireless fire detection system for harsh environments such as the lashing bridges of a container ship. Serious cargo-related fires on board of container ships have occurred at the rate of almost one per month. The increased size of these ships has a real impact on the potential severity of such incidents that often ends with the loss of the ship and the entire cargo. The first tests on board have shown that a significant increase in automatic fire detection is possible even in rough environments on deck. *(HANSA)*

More shipping losses due to Covid-19?

In its Safety and Shipping Review 2020, marine insurer Allianz reports 41 total losses of ships around the world in 2019, down from 53 in 2018. This represents an approximate seventy per cent decline over ten years as a result of new regulations, better training and technological advancement. Over 950 shipping losses have been reported since the start of 2010. The shipping industry has continued to operate through the pandemic, despite disruptions at ports and crew change problems. Yet, Allianz says its consequences could lead to higher risks and more losses. Among these are: difficult crew exchanges impact crew welfare and could increase human error; disruption of maintenance heightens the risk of machinery damage; with reduced or delayed surveys and port inspections unsafe practices or defective equipment may go undetected; cargo damage and delays are likely as supply chains come under strain; the ability to respond quickly to an emergency could be compromised with consequences for major incidents, which are dependent on external support; the number of cruise ships and oil tankers in lay-up pose significant financial exposures, due to potential threat from extreme weather, piracy or political risks. *(Ship and Offshore)*

Pure hydrogen gas engine

Misubishi Heavy Industries is conducting tests on a pure hydrogen gas engine based on its four-stroke diesel and gas engine technology. The modified single-cylinder gas engine, with a bore of 170 mm and stroke of 220 mm, is based on Mitsubishi four-stroke engine GSR series, which is available in six- to sixteen-cylinder configurations. The engine is being tested to identify the conditions to achieve stable combustion of 100 per cent hydrogen without emitting CO_2. Initial applications for the engine will be in industrial power generation, but the research could yield benefits for the marine market. Hydrogen has a wide flammability range and a high combustion wave propagation velocity, making the engine prone to abnormal combustion, such as backfiring and knocking. Results of the tests reveal the maximum output is 340 kW for a six-cylinder engine and 920 kW for a sixteen-cylinder model. *(Riviera)*

CSA objects to EU plans to restrict open-loop scrubbers

It has been reported that in the last week of February, the Transport Committee of the European Parliament has accepted a resolution to encourage EU member states to restrict open-loop scrubbers. The Clean Shipping Alliance (CSA), representing a group of leading shipping companies, regrets this resolution on the basis of the fact that, according to a study of CE Delft, the CO_2 footprint of very low sulphur fuel oils is much higher (ten to fifteen, potentially 25 per cent) than of heavy fuel oil because of the additional refining required to remove the sulphur. Whilst the increased CO_2 from a scrubber system is in the range of 1.0 to 1.5 per cent only. CSA adds that there is no scientific evidence of open-loop scrubbers causing a negative impact on the marine environment. *(Hellenic Shipping News)*

23-MW fuel cells for Danish ferry

Ferry company DFDS and partners have applied for EU support for the development of a ferry powered by electricity from hydrogen fuel cells. Green hydrogen is to be produced by a projected offshore wind energy powered electrolyser plant in Greater Copenhagen. The ferry has the working name Europe Seaways, is designed for 1800 passengers and 120 lorries or 380 cars. It will operate on the Copenhagen-Frederikshavn-Oslo route. Both the roundtrip time and bunkering interval will be 48 hours.

Power production on board will be by PEM Fuel cells. Engine power is 23 MW and its fuel will be compressed hydrogen. The fuel tank capacity is 44 tonnes. The ferry will reduce CO_2 emissions by 64,000 tonnes per year. If the project develops as projected, the ferry could be operational in 2027. *(DFDS)*

NEW GREENER TYPES OF SHIPS NEED A LOT MORE R&D

The greening of shipping needs much more R&D, not only in finding alternative fuels, but also for the design of completely new ship concepts. For this R&D, al lot more cooperation has to be initiated between maritime research institutes, like MARIN or Norwegian SIINTEF Ocean AS, shipowners, ship designers, important suppliers, such as the engine manufacturers and the ones that deliver important support systems for heating, air-conditioning, etc., and last but not least of course the shipyards. Because on their own, most of the shipyards won't be able to bring about the needed greening of shipping as they lack both the money and knowledge.

The latter was one of the findings of the interesting webinar "Designing the ship of the future 4" organised by Mare Forum Conferences. The Rotterdam based Mare Forum Conferences are considered by many to be among the most influential global forums for the maritime and shipping industry. Before the Covid-19 pandemic, the conferences were held in Europe, North, Central and South America, Asia and the Middle East. Due to the circumstances, the conferences are now replaced by webinars that gain more and more listeners.
The webinar mentioned took place on the 4th March and was moderated by Nick Brown, the Communications Manager of Bureau Veritas.

Participants were Kevin Humphreys, General Manager Market Innovation at Wärtsilä, John-Kaare Aune, CEO of Wallem Ship Management, headquartered in Hong Kong, Ali Shehab Ahmad, former CEO of Kuwait Oil Tanker Company (KOTC), John Kokarakis, Technical Director Technology & Business Development of Bureau Veritas, Martin Dorsman, Secretary General of the European Community of Shipowners' Associations (ECSA), Michael de Visser, Managing Director NIBC Bank, and Elizabeth Lindstad, Chief Scientist of SINTEF Ocean AS, the Norwegian counterpart of Dutch maritime research institute MARIN.

Existing ships indexed

This fourth edition of the "Designing the ship of the future" series that started only last autumn, was dominated by the IMO measures launched in late November to cut the carbon intensity of existing ships. According to the IMO, the introduction of an Energy Efficiency Design Index (EEDI) for existing ships (EEXI) and a new operational carbon intensity indicator (CII) marks a major step forward, building on current mandatory energy efficiency requirements to further reduce greenhouse gas emissions from shipping. The EEXI will be applied to all vessels above 400 GT. Guidelines on calculations, surveys and verification of the EEXI will follow and be finalised at MEPC 76, that will be held later this year.
The new EEXI and CII for existing ships are based on the EEDI for newbuild ships. The EEDI ensures ships are built and designed to be more energy efficient than the baseline. But as a new ship can be designed from scratch to the latest insights and state-of-the art technology, the consequences for existing ships could be far more radical. The proposals, that will have to be enforced later this year, are meant for all ships of 5000 gross tonnage and above and are set to determine their required annual operational CII. With this CII, the ship will be given an operational carbon intensity rating of A, B, C, D or E – indicating a major superior, minor superior, moderate, minor inferior, or inferior performance level. The performance level will be recorded in the ship's Ship Energy Efficiency Management Plan (SEEMP). The shipowner of a ship

rated D for three consecutive years, or E, will have to submit a corrective action plan, to show how the required index (C or above) will be achieved. That means an often costly retrofitting or when not economically viable anymore, sending the ship to the scrapyard.

Longer, more slender ships

The Norwegian maritime scientist Lindstad foresees that the enforcement of the EEXI in 2023 will speed up the need for new, greener ships that produce less carbon emissions. According to Lindstad, these ships will look different than conventional ones. First and foremost, they will have better, slender hull forms that will make the ships longer while keeping the deadweight the same. A more slender hull form is the most important factor for reducing fuel consumption. But with more longer ships, ports and terminals will also have to change their tariffs policy that is now often based on the principle of the longer the ship, the more quay length you use, the more you pay. But it can't be of course that greener ships will be punished for being longer. By the way, a range of ports, including the Port of Rotterdam, already reward greener ships with reduced port tariffs.

Humphreys, Innovation Manager at Wärtsilä, notes that with existing technology, it is already possible to build ships that produce fifty per cent less carbon emissions today. Humphreys distinguishes four aspects to consider. First, he also points to the hull form. With a better hull form and more modern, adjustable ship propellers and rudders, a bulker or tanker can already save six to eight per cent compared to its older conventional competitors. 'We are still getting a lot of cookie-cutting hulls out of the yards that provide too little fuel efficiency.' Secondly, he mentions wind assisted ship propulsion with Flettner rotors or other types of modern sails. He sees this technology quickly maturing in effectiveness while the costs become lower.

More flexibility in power

For the propulsion system itself, the speciality of Wärtsilä itself, he sees a development towards much more flexibility in power management. The main engine and auxiliaries will need to operate more often in a full range from zero to 100 per cent at for example 13, 14 knots. The power from the wind often strongly varies and the main engines have to be able to adjust to this. Humphreys expects that these new highly flexible power systems will soon become cheaper.

His fourth consideration is the development of main engines that can burn on more different alternative fuels like methanol, ammonia, hydrogen and LNG. The latter will, according to the Wärtsilä manager, still be an important source of energy for some time to come. A ship built with the technology mentioned can be lighter with less installed power and therefore also burns less fuel and produces around fifty per cent less carbon dioxide. Replacing LNG in the future by carbon-neutral or zero-emission fuels can also make these ships completely emission free. As such, they would be sustainable not only for 2030, but with zero-emission also still acceptable in 2050 when ships should have lowered their emissions still further than fifty per cent.

Too little expertise

As a shipowner, the former CEO of KOTC Shehab Ahmad has quite a lot of experience with trying to make its fleet of very large crude carriers and product tankers more energy efficient. They installed several types of technical devices on the propellor, rudder and hull and wanted to install heat waste recovery systems. All together, it delivered some percentage of fuel savings, but the breakthrough should have come from newbuildings. But when ordering new ships, the ship manager collided again and again with the shipyards that were unable to fulfil the wishes of the shipowner.

> The shipyards don't have the budgets for the R&D needed to build more sustainable ships

'We faced numerous challenges with the shipyards about the design of the ships. There isn't much R&D done there. I think that due to the economic downturn in shipbuilding in the last decade, a lot of talented engineers left and with that also a lot of expertise has been lost,' says Shehab Ahmad. He sees the interests of the shipowner and shipyard colliding where a yard wants to reach production targets while the shipowner wants foremost a fuel saving ship. 'We as a shipowner need a proven design so that our investments serve our purposes. And we had to bend a few times on the matter of innovations we wanted,' says the Kuwaiti ship manager.

More funding for R&D

According to the former KOTC-CEO, the shipyards don't have the budgets for the R&D that is needed to build the ships required for more sustainable shipping in the near future. And as the shipyards can't deliver, the R&D should come from elsewhere, for example the maritime research centres in Europe. He would like to see that these centres, like MARIN, get enough funding to do the useful studies that shipowners now need to order the new, greener ships. 'It's all about funding to be able to create a lot of beautiful solutions.' A plea that could only be strongly supported by Lindstad, who would like to see that the big maritime research institutes in Europe unite to convince the European Commission to invest more in R&D for shipping.

On his part, Wärtsilä's Humphreys also pleads for more cooperation and says banks should better manage the economical, technical and environmental risks of new technologies as greener ships are more sustainable, but of course they also have to be economically viable. De Visser, Managing Director at NIBC bank takes a positive view towards the actual developments: 'Our role is that of driver of innovation.'

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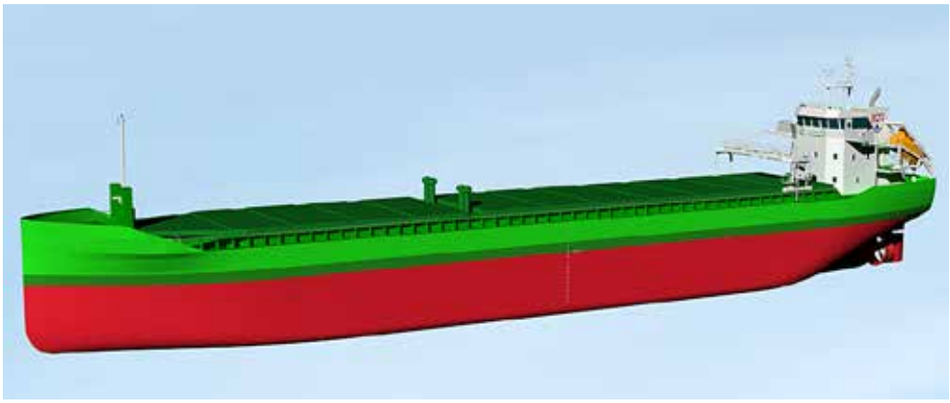

The Eco Trader 6660.

NEW ORDERS

Seven Eco Traders 6660

Arklow Shipping ULC, Arklow, has ordered a series of seven minibulkers of the Eco Trader 6660 type (yard numbers 821-827) from Royal Bodewes, Hoogezand. Delivery of the first vessel is planned in autumn 2022, after which the next vessels are to be commissioned at intervals of approximately three months.
The details of the Eco Trader 6660 are: 4267 GT, 6660 DWT – Loa (pp) x B x D (d) = 104.93 (102.98) x 15.00 x 9.50 (6.50) metres, air draught in ballast 21.00 metres. Propulsion is provided by a MaK main engine, type 6M25C, Tier II, with an output of 1740 kW at 720 rpm via a Renk gearbox, type T2Recs-630 on a controllable pitch propeller with a diameter of 3200 mm in an Optima nozzle for a trial speed of 11.6 knots. The Veth tunnel thruster will have an output of 300 kW. Two Caterpillar generator sets, type C7.1 acert, will have an output of 2 x 150 ekW and an emergency Caterpillar generator set, type C4.4 acert, will have an output of 1 x 65 ekW. The bunker capacity is 200 m^3 MGO. The vessels will be built under RINA classification and have two holds equipped with pontoon hatches that can be opened and closed by means of a gantry crane. The Eco Traders will be equipped with a Techcross Ballast Water Treatment unit with a capacity of 300 m^3/hr.

Hydrographic survey vessel

Waterschap Scheldestromen has contracted Holland Shipyards to build a new survey vessel (yard number H2020-0367). The vessel (15.15 x 4.90 metres) is expected to be delivered by the end of 2021. It will be suitable for sailing along the Zeeland coast, up to 5 nautical miles from shore. Propulsion will be provided by two permanent magnet motors (2 x 85 kW) and a generator set with variable speed, ensuring optimal fuel consumption and operational reliability by switching generators on and off automatically. The vessel is prepared for conversion into a battery powered fully electric vessel in the future.

Ecobox XL

In February, Symphony Shipping BV, Breda, ordered two project cargo vessels of type Ice class 1A Ecobox XL from Ferus Smit GmbH, Leer (yard numbers 460 and 461, imo 9931472 and 9931484). The ships will be an evolution of the successful six Ecobox (S-series) and two Ecobox DP vessels (P-series), which the yard delivered to Symphony between 2015 and 2018. This first series comprised 10.600-DWT geared cargo vessels with a single fully box-shaped hold with an open top notation and a deckhouse placed forward. Later, a dynamic positioning version of the design was developed as Ecobox DP. The new Ecobox XL design will in fact be an enlarged Ecobox. Therefore, the original Ecobox design will be lengthened by more than 21 metres to 143.50 metres and an extended beam of 18 metres enhancing the deadweight to 12,500 tonnes. The modifications in design and systems are also aimed to further enhance the excellent green performance with a reduction of the EEDI-score to a new class reference standard, whereby the bulbless canoe type bow, designed to reduce fuel costs and better sustained speed with excellent seakeeping behaviour in harsh weather and sea state conditions, is retained. Fuel consumption will be further reduced by integrating a novel ORC waste heat generator in the propulsion system. The main engine with an output of 3300 kW, Tier III, will drive a controllable pitch propeller in a nozzle. The fuel system will also be suitable for bio-blend fuels. The new vessels will have a large space for project cargoes with a cargo length of 100 metres on the tanktop and 112 metres on the completely mova-

The hydrographic survey vessel for Waterschap Scheldestromen.

The Symphony Spirit is part of the first series of Ecoboxes and will now be followed by a larger version (photo Flying Focus).

ble tween deck. The Ecobox XL will be equipped with two deck cranes. The new Ecobox XL ships are planned for delivery in October 2022 and March 2023.

IHC-designed dredgers for US and India

Cashman Dredging and Marine Contracting Co., LLC of Quincy, Ma., contracted Royal IHC at the end of January for the design and engineering of a 5000-m³ trailing suction hopper dredger (TSHD). The TSHD will be equipped with a diesel-electric configuration and the main engines will meet air pollution regulations EPA Tier IV and IMO Tier III. The design includes two dredge pumps and two suction pipes. Two azimuth thrusters will allow Cashman to easily manoeuvre in shallow-draught areas, providing the company with greater dredge project versatility. Cashman provides dredging services along the East Coast, Gulf Coast, and in the Caribbean Basin, specialising in the areas of navigation, beach renourishment, environmental dredging, and coastal resiliency. It also specialises in a wide range of marine contracting services including pier construction, jetty and revetment construction, and bulkhead construction. Delivery of the hopper dredger is planned in 2024.

In May 2020, Royal IHC had been awarded the contract for the engineering and equipment delivery for a new 6540-m³ TSHD for Weeks Marine Inc., Cranford N.J., an identical vessel to the Magdalen (yard number H256/1271, imo 9652210) that was delivered 22 December 2017. The new hopper dredger, which will sail under the name R.B. Weeks (yard number H258, imo 9652210), will be built at Eastern Shipbuilding Allanton Shipyard Panama City, Fla. Like the Magdalen, the R.B. Weeks will be equipped with IHC-designed and -built equipment, including the complete and highly efficient dredging installation, dredging automation and instrumentation, propulsion and main electrical system. The dredger will also be equipped with IHC's unique dynamic positioning and tracking (DP/DT) system and eco pump controllers, which will both further enhance its efficiency.

The details of the R.B. Weeks are: 7581 GT, 7989 DWT – Loa (pp) x B x D = 108.51 (109.00) x 24.23 x 8.31 metres. Power is provided by two General Electric (GE) diesel generators, type 16V250, 2 x 5682 hp or 2 x 3400 kW for driving two propellers and a bow thruster of 730 kW in a tunnel. The GE auxiliary generator, type 6L250, has an output of 1423 kW and the Caterpillar emergency generator, type C18, 425 kW. Two pumps (2 x 1600 kW), a dredge pump (1 x 1600 kW) and two pressure pumps (2 x 445 kW) are installed on board. Delivery and commissioning of the R.W. Weeks are expected in 2023. Construction of these three dredgers has to take place in the United States due to the Jones Act.

With technology support from Royal IHC, Cochin Shipyard will build a 12,000-m³ TSHD for the Dredging Corporation of India Ltd., Visakhapatnam. It is the first dredger to be built by Cochin at its yard in Cochin following a memorandum of understanding (MoU) signed with IHC in November 2020 for collaboration on technology and design for construction of larger cutter suction dredgers (CSDs) and TSHDs.

It seems that McKinsey's unrealistic advice from 2014 (transforming from a production

The 5000-m³ hopper dredger designed for Cashman.

The R.B. Weeks will become almost identical to the 6540-m³ TSHD Magdalen delivered in 2017.

company into a technology company) is still haunting IHC. The new building slipways in Kinderdijk and Krimpen aan den IJssel are less and less occupied. Perhaps a turning point is in sight, because IHC is in the race for an order from Boskalis for two shallow draught ultra modern hopper dredgers, but so far little more is known about this project.

Adriaen Coenen

Next Generation Shipyards, Lauwersoog, has won the tender for the construction of the new research vessel Adriaen Coenen (yard number NGS-35). The aluminium vessel (Loa x B (d) = 19.00 x 5.60 (1.00) metres) provides facilities for twelve scientists, assistants, students and other passengers, and two crew members. With a maximum draught of 1 metre, the Adriaen Coenen can cross watersheds in the Wadden Sea at high tide and ground during low tide. The new vessel will tow or push small objects, such as the Wadtower (a mobile bird observation platform). For research activities, the vessel will be equipped with hoisting equipment, a spacious working deck – with room for two rubber dinghies or a 10-ft container, arrangements for deployment of an ADCP (Acoustic Doppler Current Profiler) and multi-beam equipment, wet and dry laboratories, ICT infrastructure and communication equipment. Propulsion is provided by two diesel generators on two water jets for a maximum speed of 20 knots (cruising 16-18 knots). Range on full power is twenty hours. A diesel substitute, HVO (hydro-treated vegetable oil), will be used as an energy source. This ensures a significant reduction in emissions, such as ninety per cent less CO_2. In combination with particulate filters and a catalytic converter on the exhausts, this is at least equivalent to the emission reduction achieved with methanol, for example. Furthermore, all installations are designed to minimise energy consumption. For example, the cooling water systems will be equipped with a heat recovery system and the LED lighting will work with motion sensors and solar panels. The vessel will make use of batteries when it is dried-out and it will have a plug-in facility for port stays. In addition, maximum (thermal) insulation will be applied. The vessel is named after the sixteenth century "citizen scientist" Adriaen Coenen (1514-1587), who was a fishmonger from Schevenin-

The research vessel Adriaen Coenen.

gen. The new vessel was designed by C-Job Naval Architects in Hoofddorp and is expected to be delivered in the spring of 2022.

LAUNCHINGS

Thun Equality

At Ferus Smit GmbH, Leer, the ice class 1A Eco-tanker Thun Equality (yard number 451, imo 9817171) was launched on 24 February. The keel had been laid on 9 March. The Thun Equality is the third of a new series of four product and chemical tankers being built by Ferus Smit under Bureau Veritas classification.

The details of these tankers are: 4923 GT, 2253 NT, 7999 DWT – Loa (pp) x B x D (d) = 114.95 (112.34) x 15.87 x 10.10 (6.95) metres. Propulsion is provided by a Wärtsilä dual-fuel engine, type 6L34DF, 2999 kW, at 750 rpm, single propeller in a nozzle. The LNG tank is placed on deck. The nine cargo tanks have a capacity of 9540 m^3. The Thun Equality is to be delivered in early April to Thun Tankers BV, Delfzijl (Erik Thun AB, Lidköping). Supervision of the construction of the four tankers is in the hands of MF Shipping Group, Farmsum. A number of new techniques were also applied, such as ballast water treatment, a shore power connection and a canoe bow without a bulb. The ice class 1A Eco-tankers will be used in the Baltic service. The keel for the fourth tanker (yard number 452, imo 9817183) was laid on 7 October.

Ghibli

At Ship and Steelbuilding BV (former Shipyard

The Thun Equality is the third in a series of four ice class 1A Eco-tankers (photo F.J. Olinga).

The Ghibli is the fifth LPG tanker in a series of seven vessels. (photo F.J. Olinga).

Constructions Hoogezand Nieuwbouw), Foxhol, the LPG tanker Ghibli (yard number 842, imo 9876347) was launched on 26 February. The Ghibli is the sixth seagoing tanker being built on the Winschoterdiep for Chemgas Shipping BV, Rotterdam, under class of Bureau Veritas.

The details of the Ghibli are: 2999 GT, 881 NT, 2450 DWT – Loa (pp) x B x D (d) = 87.18 (83.27) x 14.80 x 7.00 (4.85) metres. The two cargo tanks have a capacity of 3005 m^3 for liquefied gases under pressure (butane, LPG, vinylchloride monomer). The tanker is powered by a dual-fuel Wärtsilä main engine, type 8L20DF, with an output of 1913 hp or 1408 kW at 1200 rpm on an adjustable propeller in a nozzle for a speed of 12.5 knots. The bunker capacity is 182 m^3.

The fifth tanker in the series, the Gale (yard number 841, imo 9876335) was towed from Hoogezand to Delfzijl for installation of two cargo tanks by the floating sheerlegs Triton on 18 January. The Gale returned to Hoogezand on 25 January for completion. The seventh tanker (yard number 843, imo 9876921) is still under construction.

POA 1

The first of two aluminium patrol vessels for the Port of Antwerp, the POA 1 (yard number 217), was launched by Gebr. Kooiman, Zwijndrecht, on 13 February. The innovative hybrid twin propeller vessels with Hull Vane were developed by Kooiman Engineering.

The dimensions are Loa x B x D (d) = 25.00 x 5.40 x 3.10 (1.36) metres. The POA 1 can achieve a maximum speed of 35 km/h using diesel propulsion and 22 km/h using the hybrid propulsion system. The new patrol vessels are equipped with a battery pack with a pure electric endurance of 2.5 hours at a speed of 9 km/h, which happens to be a good patrol pace. The vessels also have two other energy modes; full diesel propulsion or hybrid propulsion. This unique system results in lower fuel consumption and minimal CO_2 emissions. The diesel particulate filter and integrated exhaust gas treatment system also produce less gaseous pollutants (SO_x/NO_x). The vessels will charge up with green electricity at onshore power points operated by the Nautical Operational Cluster (NOC) at quay 1622. Delivery of the POA 1 is planned for May, the second, the POA 2 (yard number 218), for autumn 2021.

The POA 1 is the first of two hybrid patrol vessels for the Port of Antwerp.

SL-26 Anne Marie

At Casco & Sectiebouw Rotterdam (CSR), Rotterdam, the hull of the twinrigger/flyshooter SL-26 Anne Marie (yard number 222, imo 9909118) was launched and towed to Padmos Shipyards, Stellendam, on 26 February. The keel had been laid on 3 November 2020. SL-26 BV (E. van Seters & Zoon), Stellendam, ordered the multifunctional SL-26 in March 2020 for delivery in July 2021.

The details of the Anne Marie are: 385 GT – Loa (pp) x B x D (d) = 24.95 (23.40) x 8.50 x 4.00 (3.60) metres. The propulsion system consists

The SL-26 Anne Marie was launched and towed to Stellendam (photo A. Neighbourfield).

The Lady Hedwig is the third in a series of six ice class 1 A multipurpose vessels (photo F.J. Olinga).

of a Mitsubishi main engine, type S12R-MP-TAW, of 749 kW at 1500 rpm.

DELIVERIES

Lady Hedwig

Wijnne Barends BV, Delfzijl, took delivery of the Lady Hedwig, the third in a series of six Swedish/Finnish ice class 1A extremely fuel efficient multipurpose vessels. The ships were built or are still under construction under Lloyd's Register class at Chowgule & Company Pvt. Ltd., Loutulim/Goa and were designed by Conoship International BV, Groningen. The Lady Hedwig was launched on 21 July and after commissioning on 7 December 2020, the ship sailed to Eemshaven where it arrived on 20 January.

The details of the Lady H2-series with open top notation are: 2995 GT, 1531 NT, 4228 DWT – Loa (pp) x B x F (d) = 98.20 (95.10) x 13.40 x 7.80 (5.60) metres, air draught in ballast 23.00 metres. Due to model tests in ice, the installed power for the ice class vessel could be kept at a very low level. The MaK main engine, type 6M25 (255 x 400) has an output of 1600 kW and an additional 400 ekW of PTI propulsion power is available for the hardest situations encountered. The service speed is 11 knots with a fuel consumption of 4.3 tonnes/day. The bow thruster has an output of 250 kW. The Lady H-ships have one box shaped hold (67.20 x 11.20 x 8.34 metres) with a grain/bale capacity of 210,723 cft or a timber capacity of 5900 m^3 LP. The maximum permissible load on the tanktop is 15.0 tonnes/m^2. The container capacity is 40 TEU/20 FEU.

Name	yard nr	imo	delivery
Lady Hanneke	C-248	9828352	18-Sep-19
Lady Hestia	C-249	9828364	7-Jan-20
Lady Hedwig	C-250	9834985	7-Dec-20
Lady Harriet	C-251	9834997	May-21
Lady Hannah	C-252	9835006	Sep-21
Lady Habarka	C-253	9835018	Jan-22

Mohab Mameesh

The non-propelled cutter suction dredger (CSD) Mohab Mameesh (yard number 1299, imo 9869356) undertook trials and tests on the North Sea near the Maasvlakte in January. The Mohab Mameesh was launched at IHC's shipyard in Krimpen aan den IJssel on 15 May 2020 and was one of two heavy-duty rock CSDs ordered by the Suez Canal Authority (SCA), Ismaila. The second, the Hussein Tantawy (yard number 1300, imo 9869368), was launched on 23 October 2020. Both CSDs were built under class of Lloyd's Register of Shipping and will be used to maintain and improve the Suez Canal.

The details of the CSDs are: 8800 GT – Loa x B x D = 147.40 x 23.00 x 8.00 metres. They have a total installed power of 29.190 kW and a maximum dredging depth of 35 metres. The dredgers are equipped with one submerged and two inboard dredge pumps, the installed cutter power is 4800 kW. Delivery of the Mohab Mameesh is foreseen in March, and of the Hussein Tantawy in August.

Hydrograaf H 8021

On 26 February, the naming ceremony performed by State Secretary of Defence Barbara Visser and transfer of the expeditionary survey boat (ESB) Hydrograaf H 8021 (yard number 190, imo 9887798) of the Royal Netherlands Navy took place at Damen Shipyards Den Helder (DSDH). Due to the coronavirus measures currently in force, the naming ceremony and handover took place remotely via a livestream. In 2016, the Defence Materiel Organisation (DMO) issued a European tender for the acquisition of an ESB. In March 2019, DMO signed a contract for the construction of the prototype of the ESB with DSDH. The hull of the Hydrograaf (15.70 x 4.00 metres) was wheeled out of the workshop of Blackfish Marine BV, Grou, on 18 January and launched at Den Helder three days later. The design and construction of the Hydrograaf were realised in close collaboration between DMO and DSDH taking into account the following requirements: a maximum weight of 24 tonnes in connection with the maximum permissible

The non-propelled cutter suction dredger Mohab Mameesh (photo A. Neighbourfield).

The Hydrograaf H 8021 is the first Expeditionary Survey Boat for the Royal Netherlands Navy.

loading weight of the davits hoisting installation on ships such as the HNLMS Johan de Witt, Rotterdam and Karel Doorman; a speed of at least 20 knots, with very low noise requirements and limited space for recording all hydrographic equipment. The ESB must independently perform hydrographic surveys during at least sixty hours at a speed of 5 knots under tactical conditions at a distance of 100 miles from the mothership. The ESB will provide up-to-date information about the soil conditions and the situation below the waterline in places where that insight is required for supporting expeditionary maritime operations and where ships can navigate safely. On the basis of gathered environmental information, decisions will be made about the (im-) possibilities of an amphibious operation. The Hydrograaf will also perform hydrographic survey operations in support of emergency relief operations and support civil hydrographic tasks on the national continental shelf. In the coming weeks, the ESB will be prepared for handover to the navy, which will start operating the vessel after a work-up period of several weeks. The Hydrograaf has accommodation for two crew members and two hydrographers.

Three Damen tugs

The mv BBC Onyx (2011 – 12,810 GT) transported two RSDs 2513, the Senglea (yard number 515011, imo 9892195) and Gabriella Neri (yard number 515012, imo 9892200), and one ASD 2310, the Delovoy-6 (yard number 512925, imo 9835240) on deck from Haiphong and Zhuhai to the Mediterranean. The Senglea arrived in Valletta on 12 January and was handed over to Tug Malta Ltd. (Rimorchiatori Mediterranea Spa) on 15 January. The Gabriella Neri was discharged five days later in Leghorn and commissioned by Fratelli Neri SpA on 23 February. The Delovoy-6 was finally discharged in Antikyra on 21 January, after which the tug departed on its own keel to Novorossiysk on the Black Sea. It is the sixth ASD tug bought by Delo Service Co. Ltd.
The details of the RSD 2513 built by Damen Song Cam Shipyard JSC, Haiphong, are: 330 GT – Loa (pp) x B x D (d) = 24.73 (22.51) x 12.50 x 4.95 (3.45) metres. The propulsion system consists of two MTU main engines, type 16V4000 M63L (165 x 190), with a total output of 4480 kW or 6086 hp at 1800 rpm on two RR azimuths, type US 255, with a diameter of 2700 mm for a bollard pull of 75.3 tonnes and a

The RSD 2513 Senglea.

The ASD 2310 Delovoy-6.

speed of 13 knots. The bunker capacity is 77.4 m^3. Accommodation is provided for four crew members.
The details of the ASD 2310 built at Changde are: 191 GT – Loa x B x D (d) = 22.73 x 10.43 x 4.50 (4.68) metres. The propulsion installation consists of two Caterpillar main engines, type 3512C TA HD+/C on two RR rudder propellers, type US 205 Mk1, each with a diameter of 2200 mm, total output 4023 hp or 3000 kW at 1600 rpm for a speed of 12.6 knots and a bollard pull of 51.8 tonnes. The bunker capacity is 61.6 m^3. Accommodation is provided for seven persons.

Rectification

Martijn Wolters, Bsc , Chief Engineer Jan de Nul Group and member of the KNVTS branch Zeeland discovered that the details of the configuration of power plants of the CSD Willem van Rubroeck and TSHD Galileo Galilei as described in Maritime Monthly in February were not entirely correct and must be for the Willem van Rubroeck: One MAN 14V 48/60 CR, and two MAN 9L48/60 CR instead of two MAN-B&W main engines, type 14V48/60 CR and two MAN 9L48/60 CR. And for the Galileo Galilei: three two MAN B&W main engines, type 12V32/44 CR instead of two.

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WASP PUTS THE SAIL BACK INTO SAILING

Goal is 27 million kWh more and 17,000 tonnes CO_2 less

Decarbonisation of shipping is one of the greatest maritime challenges and the demand for low carbon solutions is growing. The European research project Wind Assisted Ship Propulsion (WASP) investigates how wind propulsion technology and, thus, solutions can become more commercially attractive in the future for the North Sea region.

The Interreg North Sea Europe programme, part of the European Regional Development Fund (ERDF), facilitates transnational cooperation between 49 regions in seven countries in the North Sea region. It aims to tackle the main challenges these regions face within the priority themes "Thinking about growth", "Eco-innovation", "Sustainable North Sea area" and "Green transport and mobility". The WASP project is funded by Interreg. The other half of the funding comes from the project partners to the tune of 5.4 million euros. The project started in June 2019 and will run until the first quarter of 2023.

Studies on five ships

Five shipping companies participate in WASP with different wind propulsion technologies (WPTs). First, WASP partner Van Dam Shipping installed an eConowind fixed two-wing Ventifoil system on the 3600-DWT general cargo ship Ankie. Boomsma Shipping also installed an eConowind Ventifoil system, which includes two wings integrated in a specially designed Flatrack from which a folding Ventifoil can be deployed. The WPT installation was finished in January 2021 on the vessel Frisian Sea. In May 2020, Scandlines installed a 30-metre tall Rotor Sail from the Finnish company Norsepower on the ferry Copenhagen. Rörd Braren installed a Flettner Rotor on the Annika Braren in February. Finally, Tharsis Sea-River Shipping contracted eConowind to install two of their wind-assist 3 x 9-metre TwinFoil units on their 88-metre, 2364-DWT diesel-electric general cargo vessel Tharsis. Installation of this system is the last of five installations under the WASP project and according to eConowind this is scheduled for May 2021.

Photo: The foils on the Frisian Sea (taken by the captain).

Wind is money

Within WASP, Netherlands Maritime Technology Foundation is the project coordinator and also the point of contact for the fourteen project partners from the Netherlands, Belgium, Germany, Denmark, Norway, the United Kingdom and Sweden.

The project brings together universities, wind-assist technology providers and ship owners to research, trial and validate the operational performance of a selection of wind propulsion solutions on five vessels, thus enabling wind propulsion technology to penetrate the market and contribute to a greener North Sea transport system through harvesting the regions' abundant wind potential.

The project objectives are:

- Proven WPT concepts that lead to greening of (North Sea region) sea transport;
- Identify the viable business cases for (hybrid) WPTs; and
- Facilitate a level playing field for WPT with policy instruments.

Savings

By setting up WPT trials, the project will provide validated research data. This can improve concepts and create a viable business case, which should lead to an acceleration of market uptake.

By the project's end in the first quarter of 2023, it is hoped the following savings will be achieved based on the one ferry and four cargo ships with WPTs in operation:

- 27,634,805 kWh generated with WPTs in WASP;
- CO_2 reduction of 17,637 tonnes; and
- 5594 tonnes of heavy fuel oil/marine diesel oil saved.

First ships

After 1.5 years, WASP is making good progress towards its objectives. It already started to deliver on compulsory outputs. This also includes the installation of WPT on the vessels of Van Dam and Scandlines. After installation, the system became operational in the North Sea region. The system, mechanics and electronics were tested on both vessels in different conditions, fine-tuned and updated. After monitoring, measuring and recording wind condition, fuel consumption and vessel speed, the first test trips have shown positive effects. Challenges remain with further optimisations needed to get the system operating to full satisfaction.

Policy makers and customers can incentivise companies towards technological adoption

Delivery of the WPT installation on the vessels of Boomsma, Rörd Braren and Tharsis takes place in the first half-year of 2021. In the meantime, the development of the performance indicators continues in collaboration with the Joint Industry Project WASP project led by MARIN.

'FIND OUT IF THEY WORK ON THE RIVER TO DUISBURG'

From the North Sea between Goole on the Humber (UK) and Duisburg on the Rhine (Germany), Jan Albert Bosma and his father Gerrit, co-owners of Tharsis Shipping, tell us more about the "winging" of the diesel-electric sea-river vessel Tharsis (88 metres, 2364 DWT). Meanwhile, Director Frank Nieuwenhuis of eConowind reports that the system for the Tharsis is almost ready and can be installed in May. Nieuwenhuis: 'The Ventifoils are very thick aircraft wings, which are placed vertically. The force is therefore horizontal and helps with the propulsion. In order to make optimal use of these thick wings, we have applied the principle of boundary layer suction. This "pulls" the airflow around the wing, so it does not "bypass" and instead gives maximum force: up to four or five times the force per m^2 of a normal sail. The wing must always be set optimally in relation to the wind and this is done automatically. The raising and lowering is also done automatically; the captain only has to indicate that the sails should be set.'

The Tharsis gets a Twinfoil, an innovation for eConowind, that works with a wing with a flap principle, similar to those used by aircraft during landing and take-off. Setting the wings optimally relative to the wind is done by a small third steering-wing, which is fast and reliable. The Dutch NG shipyard will install the system that must stay under the 2500 kg total weight as needed for vessel operations. The units are integrated in an aluminium Flatrack from which the folding Twinfoils can be deployed.

Excessively stable

The Bosma's: 'Boomsma's Ventifoils have a fan. With our TwinFoils the wind does that itself, so the control is energy-neutral. The system is also more compact than the one with Ventifoils. In principle, both units can be stored stacked on a hatch. The hatch width sets the height of the wings at eight metres, so that the total height will be around eleven metres depending on the draught.'

'The wings will mainly be used at sea. On the river to and from Duisburg, the wind is much more volatile, but on some long stretches without too many bridges, it may be possible. We are going to find out.'

During the measurements for the WASP research by the University of Leuven, Bosma benefits from the recently purchased monitoring system, which sends numerous sailing data to a remote server. 'In Leuven, they will make a digital twin of our ship, which enables them to test theoretical calculations against our practice.'

Bosma does not expect stability problems from the pressure on the sails. 'On the contrary. Because of our heavy cargoes, we have a low centre of gravity and the ship is quite excessively stable. The pressure on the sails will temper that stability'.

Bosma tries to make the most of the tides and can already picture how this will work: 'Now and then we stop off under the British coast, quietly on one generator set. Soon we will have wings that will blow us in the right direction for free. Especially interesting will be to see how much the tipping point of starting a second generator will shift.'

Data for knowledge

The development of a viable business case for WPT is proceeding accordingly in order to understand what factors should be considered and what factors can drive the installation of such technologies.

Vasileios Kosmas of the Kühne Logistics University says: 'Fuel savings expectations, a corporate green agenda and the potential brand value enhancement represent key drivers for companies to invest in WASP technologies. Policy makers and customers are identified as key stakeholders that can incentivise companies toward this technological adoption. Other important stakeholders with an influential role in accelerating this adoption process are insurance companies, classification societies and the crew. The uptake of WASP technologies can also benefit from a fast and effective decision-making process grounded on direct communication between the technical experts and the top-management of the

BOOMSMA IS TESTING AND TRAINING

Boomsma Shipping installed its first two eConowind Ventifoil wind-assisted propulsion units on the Dutch flagged Frisian Sea, a 6477-DWT general cargo vessel, in January. In early March, Ton Boomsma, co-owner and CTO of the company, answered some questions about the first observations made on a journey to Stade, Vasteras, Sillamae, Szczecin, Skulte, Schiedam, Molde, Riga and Bayonne in February.

'Upon departure from Harlingen, the weather was stormy. It was rough outside and the vessel was rolling. They had some small problems with the Ventifoils, so they were not in use continuously. Later, they ran into easier weather with about 5/6 Beaufort (see video on LinkedIn). From 3 Beaufort and up, the foils gave a noticeable effect and with 4 Beaufort they really delivered. The power rose to 7 Beaufort and flattened after that.'

About the effects north- or southbound, Boomsma expects some data in early March.

The system has expecienced some hiccups. 'Normal for such an innovative system. We got some alarms in the hydraulics, the wind meter on one of the units seems off and there is still some calibrating to do. And we need some support beams for the frame of the Ventifoils when in stored position.'

The crew needs time to adjust to the new outfitting as well. 'We noticed the crew likes to learn and is becoming experienced in placing and moving the units. At this moment, it takes them about forty minutes to store the foils. We expect we can gain some more time here.'

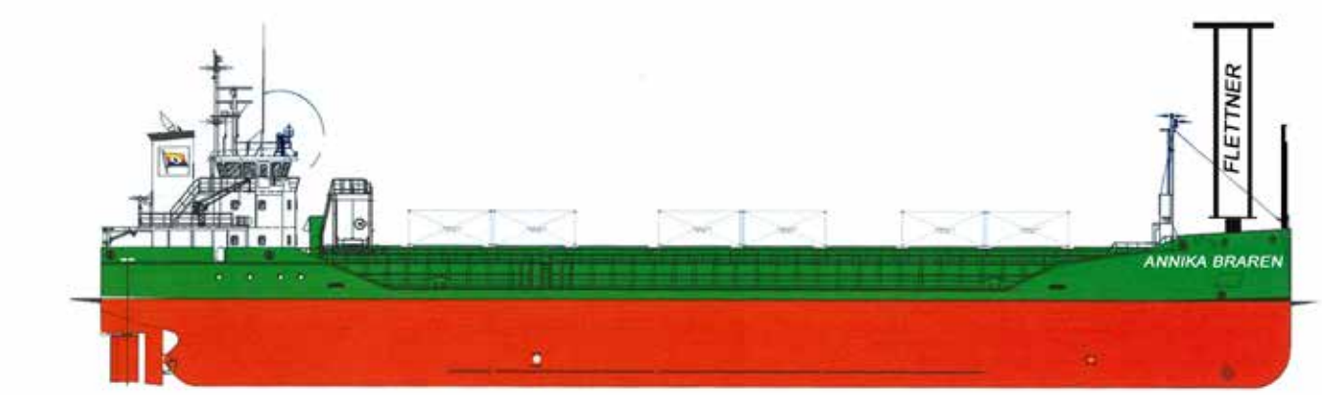
Boomsma says the foils don't influence the behaviour and movement of the ship. 'Except for the higher speed and lower fuel consumption.' In this testing period, it's hard to say anything about the gain in fuel consumption. Boomsma mentioned in a press releases a number of ten per cent. 'Personnel from eConowind is aboard for constant monitoring. Yesterday we were told: "On some trajectories we could measure hour-on-hour in varying wind speeds and found a maximum reduction of 13.5 per cent".'

Two years of testing

Tessa Remery, project coordinator, adds: 'With the help of the WASP project, we will be testing the performance over the next two years. This innovative technology must work in our daily operations and in different wind conditions. We hope to achieve savings of around ten per cent.'

Ton Boomsma, co-owner and CTO of the company: 'The installation of the Flatrack was relatively easy. We now expect that the units will offer optimal results due to their placement. Once the crew has gained experience, we do not expect any problems when handling the units with our hatch crane.'

The new Flatrack design, based on Boomsma's concept, has now been added to eConowind's product portfolio as a standard product and can be used on more ships.



The Annika Braren has a Tier III compliant engine with selective catalytic reduction (SCR) and efficiency monitoring. It has an EEDI optimised design of propulsion and hull, burns marine gas oil (MGO) and is equipped with ballast water treatment and no oil pollution interface technology for shaft, controllable pitch propeller (CPP), rudder and bow thruster. The Flettner rotor will reduce fuel consumption and emissions.

The impressive Norsepower Rotor Sail on Scandlines' Copenhagen ferry.

company. Furthermore, the construction of a viable business case requires a thorough assessment of possible technical, operational and financial risks. Last but not least, a precise statement about the payback period of the investment cannot be made. The payback period is dependent on different factors such as the actual obtained bunker savings, which vary according to the technology installed, ship size, routes of operations, weather conditions, etc.'

Characterisation, simulation and validation will make the different technical solutions transparent and comparable

Different feed-ins are being developed to be integrated into this business model. Such as decision support models, investment/fund/finance tools and solutions, market conditions, fuel/emission saving predictions for different scenarios, etc.

In the end, the performance of the WPT, emission reduction and power and fuel savings strongly influence the business case. Characterisation, simulation and in the end validation of the performance will make the results of different technical solutions transparent and comparable. This will be a major achievement of the WASP project and will strengthen the business case.

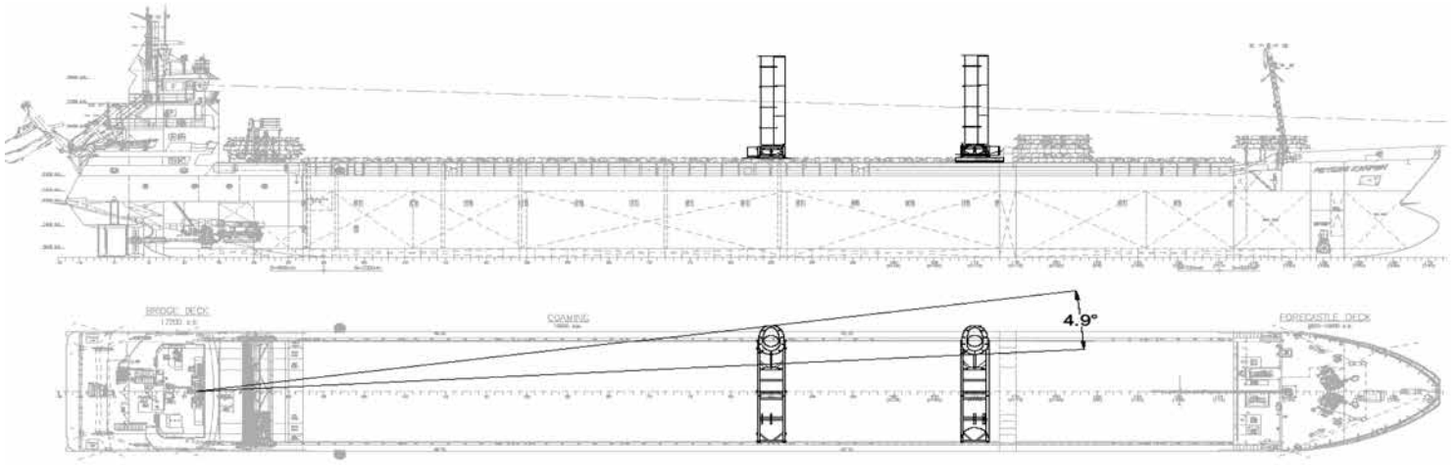
Ten recommendations

The project partners are promoting WPTs and WASP. On a national and international level, several meetings with key stakeholders from the shipping industry and the organisations delivering clean technology for shipping have taken place. Barriers that block WPT uptake in the market and the political regulations that are needed to overcome these barriers were discussed. This information was used in a policy brief about wind technologies for cleaner shipping, focusing on regulatory actions to promote WASP. This brief carries ten regulatory recommendations:

- Introduce a significant carbon levy, which is to be raised annually.
- Introduce a CO_2 dependent speed limit or engine power limit at sea.
- CO_2 reduction should be aligned with the 1.5°C goal of the Paris Agreement.
- More public research and development funds for "non-fuel" propulsion technologies.
- New 1.5°C compatible EEDI targets for 2025/30 and beyond.
- Include shipping in a flag neutral emissions trading system.
- Stricter regulations for ship emissions to air and water.
- New port fees based upon emitted CO_2, NO_X, SO_2 and particulate matter.
- Stop public support for fossil fuels and fossil fuel infrastructure.
- Include life-cycle assessments when assigning CO_2 savings.

More facts

The report "New wind propulsion technology – A literature review of recent adoptions" and a Master thesis on ship owners and their



This drawing highlights the bridge visibility issue of the Frisian Sea of shipowner Boomsma, which uses foils with boundary suction (illustration KU Leuven).

experiences and expectations with respect to wind propulsion are published at https://northsearegion.eu/wasp/output-library-publications/.

The project has also been highlighted in policy discussions/documents and presentations made for EU level projects. In November 2019, during the 31st IMO Assembly, a statement was delivered by the Comoros Permanent Representative, highlighting the significance and potential for wind propulsion technologies, raising awareness among IMO delegates.

This was followed in January 2020 by the submission of IMO MEPC75 Inf.26 document that highlights key aspects of WPT development, with an explicit reference to the WASP project, to help achieve the ambitious goals set out by the Initial IMO GHG Strategy and including an introduction to WASP activity. Now, project partners continue to disseminate the IMO MEPC75 Inf.26 document.

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UP TO TWENTY PER CENT FUEL SAVINGS

The Norsepower Rotor Sail on the hybrid ferry Copenhagen works in perfect conditions according to Scandlines CEO Søren Poulsgaard Jensen. 'The technology has the optimum effect when it is windy and the wind comes from the side. The route between Gedser to the north and Rostock to the south is almost perpendicular to the prevailing wind from the west, giving us favourable conditions for using rotor sails.'

These systems are expected to deliver four to five per cent fuel savings – corresponding to the same amount of CO_2 – on average, and more than twenty per cent in optimal wind conditions.

Scandlines' COO Michael Guldmann Petersen expects a four to five per cent reduction in CO_2 emissions. 'We are happy that the system is fully automated and we're expecting little in the way of technical problems. The last month of operations has been quite smooth and we see that continuing throughout the test period.'

Scandlines' naval architect Rasmus Nielsen was content with the installation 'in just a few hours during a scheduled overnight stop in May 2020, following meticulous preparation. Earlier, the ferry had been prepared during a yard stay, where a steel foundation (21 tonnes) was installed and cables were pulled. The rotors weigh 42 tonnes.'

Asked for his opinion so far, Nielsen thinks it's too early to draw final conclusions about the performance. 'We take at least one year before doing that. However, the feedback from the vessel is promising. One focus of the WASP project is the validation of performance data. This will be beneficial for our case as well.'

That data will help to decide about other installations. Poulsgaard Jensen: 'We have to await the final assessment of the operational performance of the Copenhagen. If the results are according to our expectations, we plan to install another rotor sail on sister vessel Berlin, which operates on the same route.'

Nevertheless, architect Nielsen thinks it's necessary to have more WPT installations that can be used as benchmarks. 'That's why there is still so much uncertainty about the expected performance and the corresponding business case. Projects like WASP can help to collect more proven data on WPT and at the same time raise awareness within the maritime industry.'

WASP ANSWERS TO HIGH END OF EU FORECASTS FOR 2030

Need for policy environment, regulatory framework and financing

Where does wind propulsion stand today? There have been a lot of articles and media announcements recently of new projects, installations, etc., but is it really a viable option for commercial shipping and what is the current state of play? Gavin Allwright, Secretary of the International Windship Association (IWSA), gives an overview.

Shipping is in a unique decarbonisation position among the so-called difficult-to-abate heavy transport sector as it is the only one able to harness a primary renewable energy source to power its vehicles, direct wind power. Abundant, available worldwide today without new infrastructure and delivered at no cost to the point of use with no storage requirement and with robust technology solutions coming online now.
Wind propulsion technology (WPT) retrofits can currently deliver five to twenty per cent of the vessel's energy requirement with the potential of up to thirty per cent. Where wind is used as the primary mover, this is of course well over fifty per cent.
Estimates for the potential market range from up to half of the bulker fleet and two thirds of tankers by 2030 (EU commissioned research, 2016) growing to a total fleet penetration of forty to 45 per cent in the 2050s, based on business-as-usual predictions (UK government commissioned research, 2019).

Current state of play

In the first quarter of 2021, there are eleven large vessels in operation with two more installations pending at the time of writing. These range from eight rotor sail fitted vessels to seventeen rigs installed on three general cargo vessels. We name the E-ship-1 (four-rotor new build), MV Fehn Pollux (one-rotor retrofit), the SC Connector (two 35-metre tiltable rotors retrofit); three ro-ro ferry vessels: MV Estraden (two-rotor retrofit), Scandlines MV Copenhagen and Viking Line's Viking Grace (both single rotor retrofits), the

Photo: Wallenius plans to build the car carrier Oceanbird.

The Ultramax bulker Afros carries four movable rotors.

MV Afros, an Ultramax bulker (newbuild with four movable rotors) and the Maersk Pelican, an LR2 product tanker (two fixed rotors, retrofit) recently sold to Indonesian tanker specialists Buana Lintas Lautan.

There is also a VLCC, the New Vitality, in operation with twin retractable hard sails and four suction wing systems installed on two general cargo vessels: the MV Ankie (Van Dam Shipping) and the MV Frisian Sea (Boomsma Shipping) under the EU financed WASP project. The two pending installations are a Rörd Braren vessel with a single rotor and a Tharsis Sea and River Shipping twin wing sail installation. Alongside these we also have the first "Wind ready" vessel, the MV Axios, a 82,000-DWT Kamsarmax bulk carrier.

More major players are embracing the hybrid approach, with wind propulsion at its heart

Flurry of plans

There has also been a flurry of announcements over the past year with the next two years in view: with the Canopée wind-assist newbuild destined to transport Ariane rocket sections to French Guiana, two kite installations scheduled on Louis Dreyfus Armateurs and 'K' Line vessels, MOL to launch a newbuild

LITTLE GOING ON AT IMO

There is little on the table at IMO at the moment pertaining directly to wind propulsion. We are working on a number of technical submissions (regarding adjustment to EEDI and EEXI/CII contribution), however, those are not ready yet. The most recent submission to IMO was with the MEPC75, Inf26 document (MEPC-75-INF.26-Wind-propulsion-solutions-Comoros-1.pdf, windship.org).

The WASP project also issued a policy brief a couple of months ago (20201117081940_WASP-Policybrief_Windtechnologiesforcleanershipping20201117.pdf, northsearegion.eu).

So, little going on at present, but we are rolling out as much information as we can and this level of engagement will be gaining strength this year. In addition, the past year, we have seen all major classification societies release (or pending) their public guidelines for wind assist (LR, DNV GL, ABS, ClassNK and BV –pending), so IACS has increased its focus on the subject.

The International Windship Association (IWSA) has applied for observer status at IMO to help bring additional expertise and policy input, and we hope that will be accepted at this year's Council meeting. We had a side event scheduled there in March, but postponed. We will also make more calls to all policy makers for wind propulsion to be integrated into deliberations and pathways going forward.

The Neoliner ro-ro cargo ship (136 metres) uses sails as main propulsion system for cargoes up to 6500 tonnes. The duplex rigging system should make wind powering more efficient. The main technical challenges consisted of integrating a set of four foldable rigs with a capacity of more 1000 m² of wind sails on each, finding the best compromise between performance under sails and other rules and technical requirements (stability, mechanical propulsion, etc.) and defining an energy-power production plant specifically adapted to such a design.

99,0000-DWT bulker featuring its retractable hard sail and a second VLCC on order with four hard sails for CMES/DCIS.
Joint industry development projects have also been announced by other major industry players separately, involving Cargill (wing sails) and Oldendorff Carriers (rotor sails).
In the primary wind segment, Hennessey signed on as another major cargo customer for the pending Neoliner newbuild project (136-metre, 6500-GT ro-ro vessels) joining others such as Renault and Manitou and we also saw the release of the plans for the newbuild Oceanbird, a 7000-vehicle-capacity car carrier from Wallenius Marine.
Of course, all of these projects see heavy involvement of the major classification societies and progress has been further strengthened by their releases of wind-assist guidelines and involvement in projects to improve validation and prediction approaches such as the joint ABS/MARIN WiSP JIP (Wind-assisted Ship Propulsion Joint Industry Project).

The Fehn Pollux is retrofitted with one rotor.

Traditionals

We also have over twenty small cruise vessels and small sail cargo vessels using traditional sail systems in operation, with additional sail cargo vessels joining the fleet in the next year or so for operations down the West Coast of the US (SV Ceiba), cross-English Channel (SV Lo Entropy), in the Pacific (Cerulean Project) and cross-Atlantic (TOWT). This small vessel sector is expected to continue to grow substantially too.

More than 10,700

With all of this recent activity and the really robust pipeline of undeclared projects and technology solutions emerging into pre-market status, there will be at least a doubling of large vessels installed with wind propulsion solutions in operation each year to 2023.
Which is in line with the growth required for the upper end of the EU commissioned wind propulsion report forecast of up to 10,700 installations by 2030.
There is certainly a tailwind forming, with an increasing number of major players in the industry embracing the hybrid approach to decarbonisation, with wind propulsion at its heart. The key will be to make sure that the policy environment, regulatory framework and finance facilities are all aligned to help accelerate the process.

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LATEST WASP PLANS

By 2023, the International Windship Association (IWSA) expects that over forty large wind propulsion equipped vessels will be in operation. 'The UK Clean Maritime Plan forecasts that wind propulsion technologies will become a USD 2.8 billion a year segment, with approximately 30,000 installations (forty to 45 per cent market penetration) by the 2050s,' says Gavin Allwright.

According to the IWSA, there are currently eleven large ocean going vessels with wind assist systems installed and more than twenty rigs installed along with two more installations pending this quarter. There are more than twenty smaller cargo ships using wind technology as well as sail-powered cruise ships.

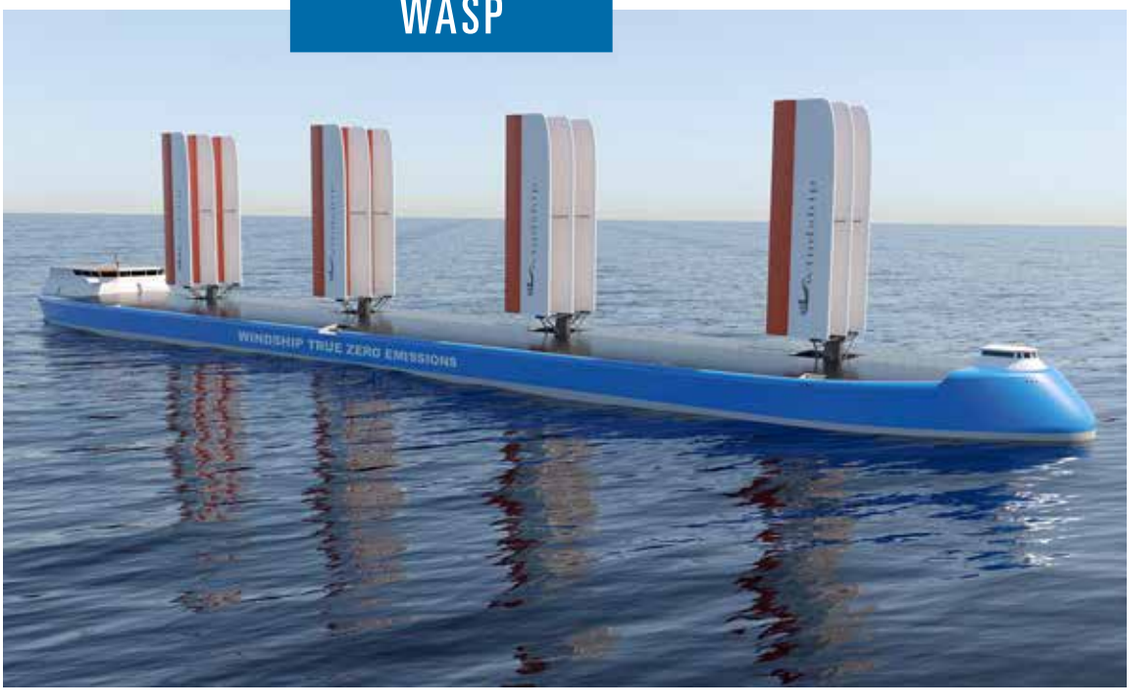
Oceanwings

Among the new wind assisted propulsion systems, is the Oceanwings 3.6.3 system from the French company AYRO. After a review of the main plans and documents of this system against the relevant rules for the classification of ships, DNV GL confirmed that no significant obstacles exist to prevent realisation of the concept.
It concerns a 363-m^2 two-element wingsail, several of which can be installed on board vessels to add wind power to the propulsion.
AYRO is manufacturing four Oceanwings to be fitted on the Canopée, a ro-ro vessel under construction at Neptune Marine Shipyard. It will be commissioned towards the end of 2022 by French shipowner Jifmar Guyane and operated by Alizee, a joint-venture company between Jifmar and Zephyr & Borée, to transport part of the Ariane 6 rocket programme being developed for the European Space Agency.

Solid Sail

Chantiers de l'Atlantique announced progress with its solid sail concept. As the next step in the technical validation necessary to commercialise the Solid Sail/AeolDrive solution for large ships, the shipyard will install prototypes of the system for testing at the shipyard. In the fall of 2021, they will install a 125-foot-tall mast that deploys a 550-m^2 sail and that will be followed by a full-scale model standing 311 feet in height in 2022 with a 1200-m^2 Solid Sail. The centrepiece of the system, the rigging named AeolDrive, a mast tiltable through 70°, is a balestron rigging able to rotate through 360° permitting the vessel to remain on course without the manoeuvring traditionally required by a sailing ship.
Chantiers de l'Atlantique says that the first commercial application for the Solid Sail/AeolDrive solution is destined for a 200-metre long cruise ship. These ships will use both sails and an engine for pro-

Photo: The Canopée will be built by Neptune Shipyard for Jifmar Guyane and is to be delivered at the end of 2022.



Windship's triple-wing rigs produce a driving force several multiples greater than single-masted solutions of the same height currently being promoted in the industry.

pulsion, achieving a fifty per cent reduction in greenhouse gas emissions. Other applications being considered are cargo ships and large pleasure boats.

Windship Technology

British company Windship Technology has a whole-ship solution to tackle CO_2 emissions from ships, launching its emissions-free bulk carrier and tanker designs alongside an investment partnership with DNV GL.

Technical Director Simon Rogers and his design team developed and tested the company's patented high performance triple-wing rig at the Wolfson Unit in Southampton. The technical team further developed a new diesel electric ship drive system that eliminates CO_2, NO_X, SO_X and particulate matter to True Zero while also incorporating large solar arrays, carbon capture, optimised hull shapes and specialised weather routing software into the overall design package.

The triple-wing rigs produce a driving force several multiples greater than single-masted solutions of the same height currently being promoted in the industry. The 48-metre Windship Technology rig is stowable on deck through a stowage solution to aid port navigation and cargo handling. Its composite structure is borne out of technology and design from the wind turbine industry, ensuring reliability and longevity for more than 25 years.

The company also announced a partnership investment with the registrar and classification society DNV GL, which will be conducting both an outside-in and inside-out verification to fully assess the whole-ship design with a view to classifying emission reductions, safety and operability.

World's largest

RoRo ship owner and operator Wallenius Wilhelmsen unveiled the beginnings of its designs to commercialise the concept of the world's largest sailing ship that would transport cars, vehicles, and machinery across the Atlantic.

Wallenius' own preconditions for going forward with Oceanbird stipulated a ninety per cent reduction in emissions, economic feasibility and a 2021 order date, all of which were deemed within reach. Oceanbird will measure 200 metres in length and 40 metres across, with a carrying capacity of up to 7000 vehicles.

Early investigations confirmed that solar power would not provide enough energy to cover more than onboard electrical systems. Wave energy, though prolific, proved difficult to exploit. The team looked at sails, Flettner rotors and kites, but to meet requirements of strength, reliability, safety and durability, rigid wings were found to be the most viable solution.

The design now incorporates five rigid wings with a total area of 7500 m^2. The wings will stand 80 metres tall and be retractable to less than half that using telescopic construction. Oceanbird will have engines on board in order to ensure safe passage and enable manoeuvring in harbours. They are evaluating different fuel alternatives, but haven't made a decision yet.

Wallenius has teamed up with SSPA in Gothenburg and the Royal Institute of Technology in Stockholm to explore and qualify the various technologies. The group received national funding from the Swedish Transport Administration to kick-start the research project in 2019. A revised concept was launched in September 2020.

Oceanbird will employ a high degree of automated sailing technology, but onboard crew will still be essential.

It seems that cargo owners are eager to be the first to have their vehicles delivered by a wind-powered ship. Wallenius says that reduced speed is a factor, but it turns out speed is not the most important thing for clients. Reliability is more critical.

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ENKHUIZER ZEEVAARTSCHOOL BEGINT WASP-CURSUS

eConowind: alles helpt bij marketing

De Enkhuizer Zeevaartschool is in februari begonnen met de Engelstalige module "Wind-assisted ship propulsion" (WASP). De module is een vast onderdeel van het onderwijs, maar staat ook apart open voor andere geïnteresseerden. Zo geeft Frank Nieuwenhuis van leverancier eConowind er binnenkort een lezing over WASP.

Foto: het oefenschip Kaatje bij de zeevaartschool draagt nog geen foils of rotors, maar brengt studenten wel bewustzijn voor de wind bij (door EZS).

De Enkhuizer Zeevaartschool (EZS), opgericht in 1978, is de enige zeevaartschool in Europa waar de focus ligt op het leren navigeren van schepen onder zeil. Algemene onderwerpen als (astronomische) navigatie, bepalingen ter voorkoming van aanvaringen, scheepswerktuigkunde en scheepsbouw worden aangevuld met specialistische onderwerpen als langs- en vierkantgetuigd zeilen, zeilschipontwerp en zeilstabiliteit.
De leerlingen hebben zeer diverse achtergronden en leeftijden. 'We hebben inschrijvingen van over de hele wereld,' zegt EZS-directeur Cosmo Wassenaar. 'De leeftijden lopen van zestien tot zestig. Veel studenten willen doorgroeien naar officier of kapitein op een groot zeilschip op zee of op de binnenwateren, maar we bedienen ook mensen met interesse in de zeilvaart, die hun kennis willen verdiepen.'
Wassenaar kwam halverwege de jaren negentig naar de zeevaartschool. 'Een opleiding waarbij ik het geleerde direct kon toepassen, zonder jaren in de schoolbanken te moeten zitten. Precies wat ik nodig had.' Na twee winters op school volgde de praktijk, waarin hij na diverse zeilschepen kapitein werd op de Clipper Stad Amsterdam. 'Dat maakt deze school zo bijzonder: mensen die hier zijn opgeleid, brengen de praktijk terug in de klas.'

Waarom WASP

De afgelopen jaren is veel onderzoek gedaan naar gebruik van de wind op motorschepen in de handelsvaart. 'De gebruikers van deze technologieën zijn de officieren op deze schepen; kennis van het hoe, wat en waarom lijkt me dan geen overbodige luxe. Hoe je met een schip vaart en daarbij optimaal gebruikmaakt van de wind is bij onze studenten dan wel bekend, maar bij WASP komen nieuwe zaken naar voren en wordt bij bepaalde onderwerpen meer de diepte ingegaan. Leerlingen van onze studierichting Grote zeilvaart, die doorgroeien naar de handelsvaart of gaan varen op nieuwe schepen met moderne WASP-technologieën, krijgen zo net dat stukje extra kennis mee. Er is nauwelijks nog praktijkervaring met het gebruik van deze technologieën, er zijn niet veel "zeebonken" die hun ervaring kunnen delen met onze studenten. Toch zijn we erin geslaagd enkele docenten aan te trekken met kennis over theorie en praktijk van door de wind ondersteunde scheepvaart.'
'De cursus begint met de ontwikkelingen uit het verleden en een overzicht van beschikbare windhulpmiddelen, inclusief de mechanismen achter de nieuwe generatie zeilen. Praktische overwegingen voor ontwerp en bediening van de windondersteuning worden behandeld. Studenten maken kennis met kenmerkende interactie-effecten tussen WASP-systemen en de hoofdvoortstuwing, koers houden en routering en commerciële exploitatie.'
De cursus duurt 24 uur, is verdeeld over een aantal dagen en wordt vanwege corona grotendeels digitaal gegeven. 'We gaan deze opleiding volgend jaar uitbreiden, want ik verwacht dat de interesse voor WASP toeneemt en dat de zeilvaart weer mede bepalend wordt in de scheepvaart.'

Opleidingen

eConowind begeleidt reders als Van Dam en Boomsma uitvoerig bij de techniek en omgang met de WASP-uitrusting. Dat gebeurt deels aan dek, maar ook voor een belangrijk deel op de brug. Nieuwenhuis: 'Wat je op je windmeter afleest, is iets anders dan de masten voelen, dus daar moet je gevoel voor ontwikkelen. We hebben twee mensen in dienst om de installatie technisch goed in te stellen en de dek- en brugbemanning er vertrouwd mee te maken. Bij Boomsma varen we nu twee maanden mee en denk ik dat het systeem volgende maand automatisch werkt. Van Dam heeft inmiddels twee bemanningen die ermee overweg kunnen. Want bemanningswissels zijn wel een dingetje om rekening mee te houden.'
Nieuwenhuis en collega's merken veel positieve aandacht voor WASP in opleidingsland. 'Ik heb nooit geweten dat we zoveel maritieme opleidingen hadden. De zeevaartschool op Terschelling toonde belangstelling en bij de Enkhuizer Zeevaartschool kunnen we desgewenst ook meewerken aan de cursus.'
Desgevraagd meldt Herbert Koelman van het Maritiem Instituut Willem Barentsz/NHL dat WASP 'een van de toepassingsonderwerpen in het nieuwe programma van de master bij het MIWB' wordt. 'De STCW-eisen en hbo-competentiedruk op het programma maken het niet makkelijk zoiets "erbij" te doen. Wellicht dat vanuit dit onderwerp in de MSc iets kan terugvloeien in de BSc.'

De Frisian Sea van Boomsma Shipping vaart met twee eConowind Ventifoils (foto Boomsma Shipping).

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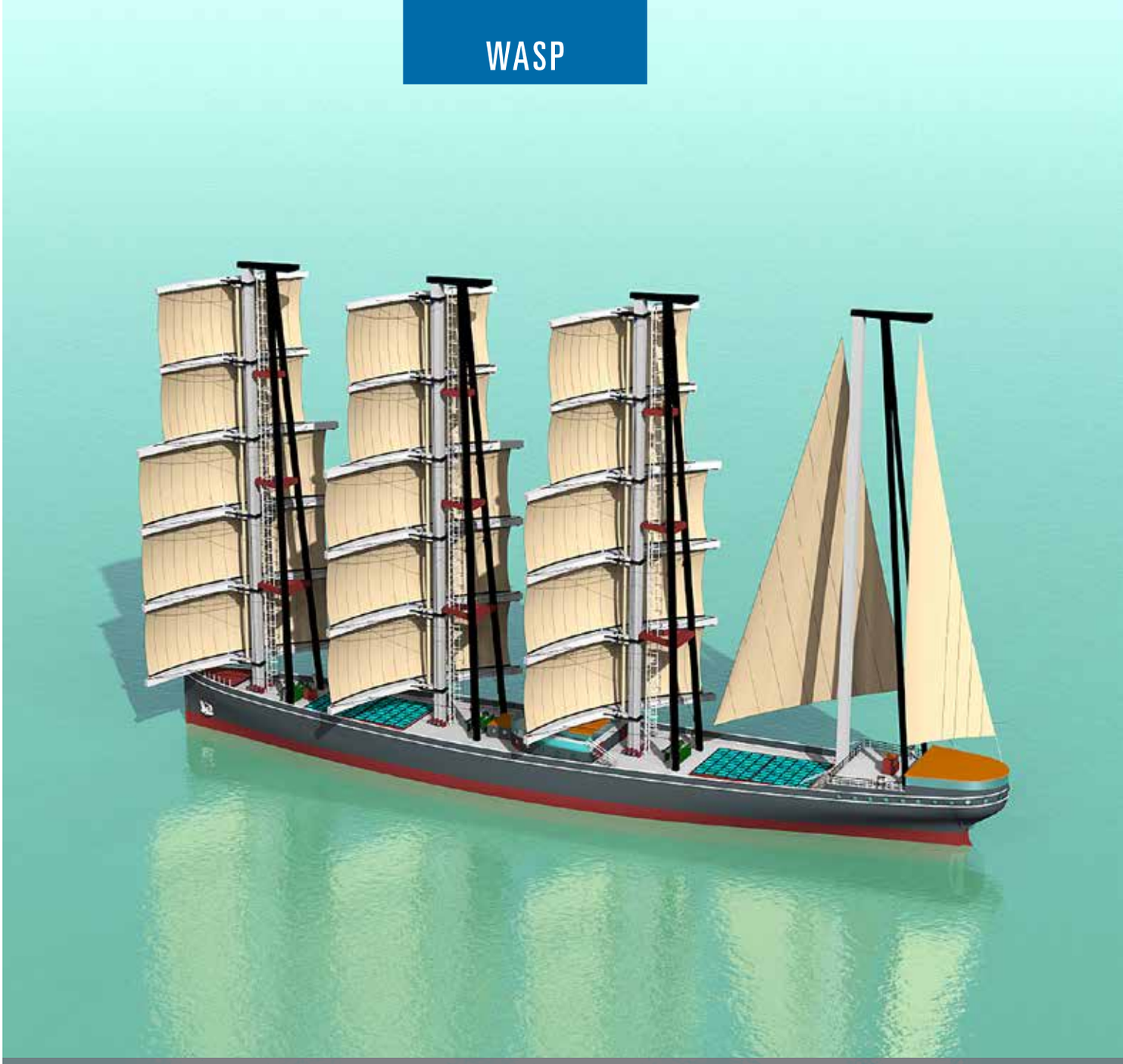
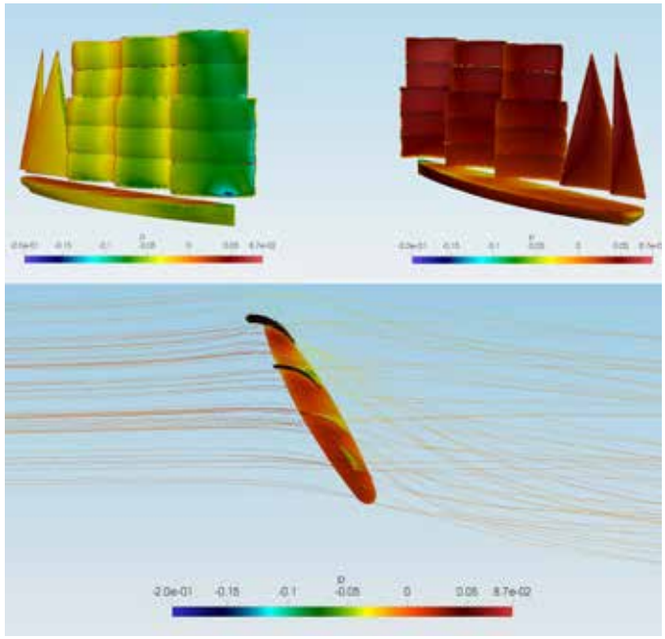


WELLICHT BETERE TIJDEN VOOR MODERNE VIERMASTER

Het Windschipproject (www.windschip.nl) keek naar aanleiding van de vraag van Arjen van der Veen van Fairtransport naar de mogelijkheid van een groot snel zeilend vrachtschip. De ruim 113 meter lange Windfreighter is een voorbeeld van doorontwikkeling naar zeilende vrachtschepen met grotere tonnages. Dit schip zal naar schatting vijftien à twintig miljoen euro kosten.

Foto: de Windfreighter is als viermastbark getuigd.



Drukverschillen op de zeilen van de Windfreighter (TWA 60°). De totale druk op de zeilen geeft onder meer de krachten op masten en steunmasten.

Het ruim tien jaar oude ontwerp van de Ecoliner.

De lijnen van de Windfreighter zijn volgens Ron de Vos van Windschipproject vergelijkbaar met de extreme clippers en recent verbeterd na onder meer weerstands- en liftonderzoek. De maximale snelheid zal ruim twintig knopen zijn, het gemiddelde rond de veertien knopen.

Het energieneutrale schip kan zich als "Tesla op zee" terugverdienen

Het tuig is semi-dyna. De gebogen ra's en zeilen worden via een braslier bediend. Het zetten en oprollen van de zeilen gebeurt volautomatisch. Het voordeel van dit type tuig boven moderne langsscheepse tuigen is dat het zeiloppervlak maximaal is, zodat geen extra lichtweerzeilen nodig zijn en dat de ra's tot dertig graden kunnen worden gebrast, zodat maximaal aan de wind kan worden gezeild. Het tuig is onderworpen aan een CFD-onderzoek (*computational fluid dynamics*). Daarbij zijn de *lift* en *drag* beoordeeld.

Terug te verdienen

Van der Veen was in de periode 2008-2012 bezig met het concept van de Ecoliner. Die 8000-tons "motorzeiler" werd geraamd op 25 miljoen aan bouwkosten en werd nooit gebouwd. Van der Veen: 'We hebben dat concept goed uitgerekend en kwamen uit op een brandstofbesparing van veertig procent. Nu zouden we dat concept aanvullen met de sterk verbeterde accu's, zodat ook bij te weinig wind voortstuwing voorhanden is.'

Hij roemt het verbeterde onderwaterschip van De Vos en de lagere kosten van de masten ('200.000 per mast'). Hij denkt dat het energieneutrale schip zich als "Tesla op zee" kan terugverdienen. 'Denk aan uitgespaarde brandstofkosten van 6500 euro per dag, dus 1,8 miljoen per jaar.' Hij is doende het zakenmodel aan te scherpen met behulp van steunprogramma's en nieuwe benaderingen van emissiewaarden. Daarmee wil hij de komende tijd de boer op.

Afmetingen Windfreighter

Lengte romp	113,60 m
Lwl	107,82 m
Breedte	18,46 m
Diepte in ruim	12,35 m
Diepgang	8,80 m
Deplacement	7350 ton
Cb	0,40
Cp	0,59
Cx	0,69
LCB	53,94 m
L/B	7,06
Zeiloppervlak	4268 m^2
Lead	4%

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HUMAN FACTORS AND WIND-POWERED VESSELS

Intensive training for bridge crew will see larger fuel savings later

Rotors are simple, reliable, easy to operate and produce proven fuel savings of up to twenty per cent. Complicated routing through archipelagos means fuel savings are lower (1.5 to two per cent). Flettner rotors as on the Viking Grace have better performance on the open sea. Providing guidance for the crew can ensure that rotor sails are used to their full potential.

Photo: The Norsepower rotor sail on the Viking Grace. Good communication between crew and technology providers improves the usage of any automatic technology.

‘THE BRIDGE CREW MUST KNOW WHAT TO DO AND WHAT THE SAVINGS ARE’

David Newman wrote about his visit to Viking Line’s Viking Grace (2013). ‘On a Monday morning, I arrived at Stockholm’s Stadsgårdskajen terminal to interview the crew of the Viking Grace. Since 2018, the 57,000-GT luxury RoPax ferry has operated a single Norsepower rotor sail on its route between the Swedish capital and Turku, Finland, via the complex Åland Archipelago.’

‘While the engine crew reported very little change in their tasks and no complaints, the navigators and master provided special insight into rotor sail operation. Many might assume that humans are designed out of rotor sail operation through automation, but this was found not to be true. Granted, all rotor sails do function automatically. Onboard or onshore software controls their speed and rotation direction to extract the maximum thrust available from the existing wind conditions, based on real-time data for wind speed and direction. But, decisions by the bridge crew about when to reduce main engine power are entirely manual and can greatly impact fuel saving performance.’

‘If this is left unacknowledged, bridge crews will be frustrated by not being able to access fuel savings data or calculation methodologies, which could help improve their understanding of the system and their navigational decisions. Giving the bridge the best possible information for their decision-making is key to ensuring that rotor sails are used to their full potential while simultaneously reducing the burden of their already-demanding workload.’

‘A myriad of quite simple solutions exist, which can help to achieve this. Shipowner investment in high-quality, in-depth training ensures the crew’s understanding of sailing to save fuel. Supporting this, proper design of user interfaces can instruct crew on how much main engine power can be reduced while maintaining speed. Such initiatives increase bridge crew motivation, as do the introduction of financial or competitive incentives for crews of vessels with low fuel consumption.’

‘Finally, improvements in communication between crew and technology providers are generally an invaluable measure to improve the usage of any automatic technology. These relatively simple measures are low-hanging fruit and should be adopted before further complex technological solutions are implemented, such as route optimisation. The stacking of ever more disjointed and fragmented systems atop one another risks harming usability and can result in misuse. A successful Fourth Industrial Revolution for shipping must rely on automated and smart technologies being transparent and integrated and human factor issues should be addressed first, before ever more complexity is introduced.’

(Extract from Newman’s publication in The Naval Architect of November 2020)

During the Blue Week last year at MARIN, project manager Nicole Costa explained some facts about the Wind Assisted Ship Propulsion (WASP) project at SSPA Sweden. This maritime consultancy in Gothenburg and Stockholm is active in ship design and hydrodynamics, naval technology and human factors, alternative fuels, environment and energy efficiency and ocean energy and conversions. Costa is a project manager in Gothenburg.

SSPA’s role

SSPA evaluated the performance of wind propulsion systems installed on five vessels on full scale, developed performance indicators, described shipowners’ and crews’ expectations and experiences of operational performance, the effects of wind assistance on typical operations and the risks associated with it.

Costa: ‘Using wind power technologies in shipping will create other operational conditions compared to conventional shipping. When designing and developing new wind-powered vessels, it’s crucial to account for the effects on the operations and crew. We looked at the expectations/experiences of shipowners and crew members with Flettner rotor installations, the human activities on board, the interaction with the rotors and the impact of the rotors on those activities. Furthermore, it brings changes to operations and tasks within manoeuvring, maintenance and training. These questions and observations have implications for design aspects of the Flettner rotors and software, the safety on board and the performance of the ship system.’

Human factors

As a Master’s student at Lund University, David Newman wrote a thesis with SSPA for the WASP Project. He described the innovation system of Flettner rotors and explored the human factors. He described the evolution of the sector, mapped the key actors and innovations, used crew and shipowner experience to improve operations and produced recommendations for expanding design and operations and improving decarbonisation policy.

Fuel savings still depend on crew attitudes and usage of the system

Newman spoke with technology providers such as Norsepower, Anemoi, Emden-Leer University, technology users (Fehn Ship Management, Maersk Tankers) and potential users such as Scandlines, Donsötank, Stena Teknik.

Nicole Costa: 'Training the crew can raise the savings from two to up to twenty per cent.'

He interviewed crews and observed on board the Viking Grace, one of only six ships in the world operating a Flettner rotor (see accompanying article).
Newman now works for the Zero Emissions Ship Technology Association (ZESTAs) and is compiling a compendium of regulations, standards and policies for zero-emission ship technologies.

Overall findings

So far, rotors are simple, reliable, easy to operate and produce proven fuel savings of up to twenty per cent. Sailing through archipelagos means fuel savings are lower (from 1.5 to two per cent), which means that Flettner rotors perform better in open sea. The rotors have no impact on cargo or passenger handling.
They require very little maintenance. About once a month, an engine crew enters inside the rotor by climbing up with harnesses to fifteen to twenty metres to inspect the welding and drive motor. This can be done by hired engineers. In this case, the ship's crew does no maintenance work.
Bridge crew welcome the Flettner rotor's automation, because it minimises additional workload: the rotor's rotation speed and direction are automated based on wind conditions. In regular traffic, the route is pre-programmed, so the rotor turns on and off automatically when entering or leaving port. If in irregular traffic, like a tanker or general cargo vessel, the crew has to turn the rotor on and off when entering or leaving port.
However, fuel savings still depend on crew attitudes and usage of the system. Understanding of fuel savings from training and motivation to save will impact the performance. Large savings come from powering down the main engine, which is entirely the bridge crew's choice and depends on their input.

Shipowners should motivate crews to maximise fuel savings

Training is important for savings. One vessel with about one hour of crew training achieved savings of 1.5 to two per cent, while another vessel with four to five days of crew training reached savings of up to twenty per cent.

Recommendations

Technology providers should incorporate crew feedback directly into software design and optimisation; navigational experience of when wind propulsion should be turned on and off depending on the moment of the voyage, geographical location and wind conditions can avoid heeling or drift of the ship. Otherwise the captain needs to manually make such decisions, increasing the workload.
The display panels should clearly instruct the bridge crew how to achieve highest fuel savings, for example on open sea or in constricted waters. When thrust power produced by the rotors is shown in kW on the display, the crew preferred a percentage of total engine power, so they can convert it to knots and determine how much the main engine should be reduced.
Shipowners should motivate crews to maximise fuel savings. One vessel has a "pool points" system. Increased energy efficiency of the vessel produces increased pool points, which means higher earnings for the crew. Another company displays fuel savings of each ship to create 'natural competition between the crews of the vessels on the route. Management compares fuel consumption, producing a competitive incentive to save fuel.'
Shipowners who invest in extensive training for bridge crew early on will see larger fuel savings later.

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RETROFITTING SHIPS WITH WIND PROPULSION

While the fuel savings and reduced emissions of wind propulsion technologies (WPTs) make a compelling case for their wide-scale deployment, it is equally important to consider the implications for regulatory compliance when installing WPTs on existing vessels.

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It is imperative that the WPT retrofit process does not violate the protocols of the International Maritime Organization (IMO), so that WPTs can be certified for use by an appropriate legislative body (for example the Royal Institute of Naval Architects), says Josh Lacey, assistant professor at the Department of Mechanical Engineering of the KU Leuven.

Bridge visibility

'The Convention on the International Regulations for Preventing Collisions at Sea (COLREGs) is one example of the safety considerations that arise during the installation of WPTs on existing vessels.

Josh Lacey: 'Any modifications made to integrate the wind propulsion technologies with the ship should in no way allow the ingress of water.'

The COLREG standards are primarily concerned with issues related to visibility and navigation lights to avoid impact events at sea. In practice, the addition of one or more vertically-mounted WPT units may impede bridge visibility or the operation of the lights. This will potentially require that navigation lights are relocated or more lights are added to the ship. The requirements for visibility may also impose constraints on the placement of WPTs that could compromise their performance.'

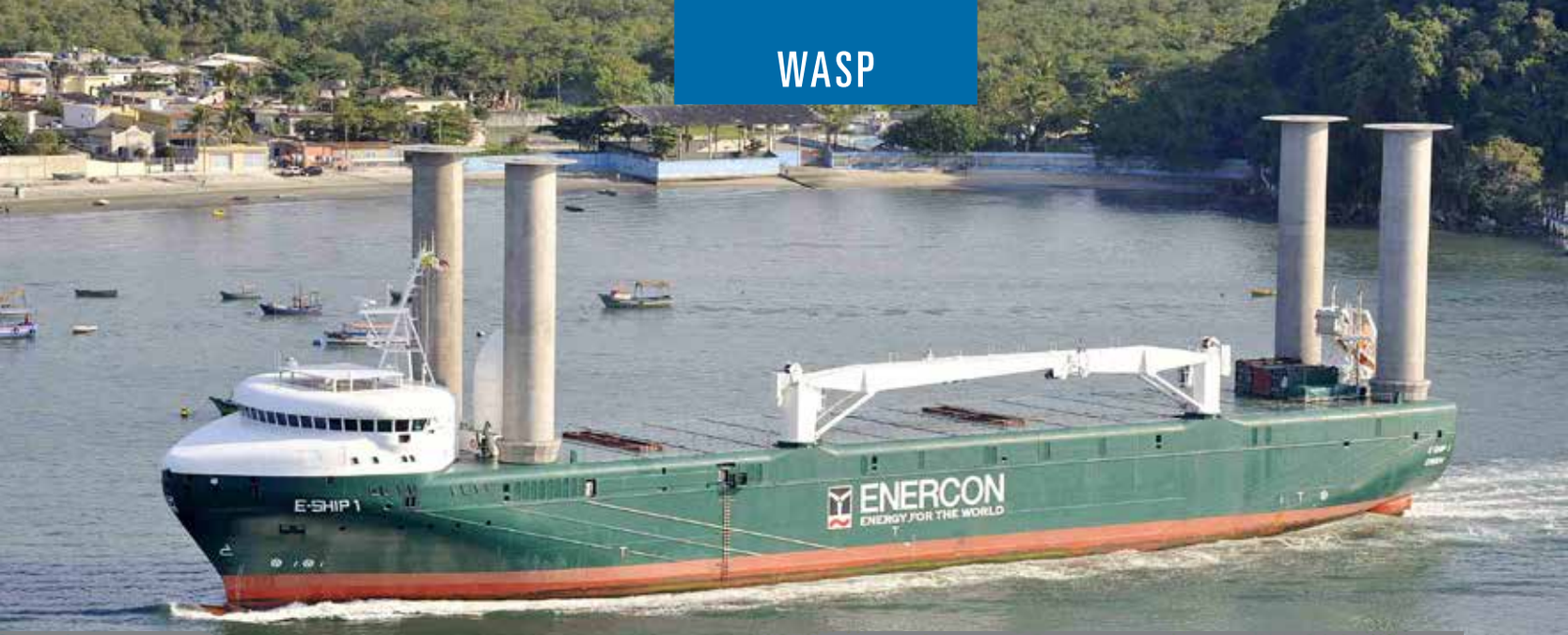
Reinforcement needed

'There are several other safety factors involved in the retrofit of existing ships. Firstly, any modifications made to integrate WPTs with the ship should in no way allow the ingress of water. Secondly, ship stability and structural integrity should not be adversely impacted by the WPT installation. In the case of lightweight deck structures, there will likely be a need for structural reinforcements when mounting the WPT.'

> Ship stability and structural integrity should not be adversely impacted by the WPT installation

'The choice of WPT will also impact the scope of modifications to the ship, as some technological solutions require a direct connection to the deck, such as a Flettner rotor, while others can be mounted indirectly in a modular configuration, such as suction sails integrated with a flatrack or flatbed container.'

'Finally, passenger ships, which have higher standards for permissible noise and vibration than cargo vessels, introduce additional requirements on WPT retrofit installations to ensure that noise and vibration threshold levels will not be exceeded,' Lacey concludes.



MAGNUS DOES THE TRICK

Flettner rotors after a decade on board

Flettner rotors use a phenomenon of fluid dynamics known as the Magnus effect to propel a ship. The thrust and direction depend on wind speed and direction, vessel heading, rotor height and diameter and surface properties of the rotors. The driving principle is that, when a cylinder is rotated about an axis, and a medium (air or water) flows past it perpendicular to the axis, a force is generated in a direction orthogonal to both the axis and flow stream. This force results from a pressure difference across the two halves of the rotor and is known as the Kutta-Joukowski force.

The Magnus effect, the physical concept behind the Flettner rotor, makes a spinning body deflect off a straight path. This deflection depends on the manner in which it spins. A pressure difference between the two halves of the body creates a force that alters the course of the body. This pressure gradient is directly related to the geometry of the object and its kinetic properties (roughness coefficient, form factor, speed of approach, angular velocity).

The generated force, the Kutta-Joukowski lift, plays an important role in marine hydrodynamics and naval architecture. It's the guiding force that is utilised by Flettner rotors.

By flow separation, the body deviates off its originally intended path. This occurs when the flow around a body is no longer able to stick to the surface due to physical alterations, which creates a wake (warp in the flow downstream of the body). Due to the spinning nature, this wake is formed in certain regions that create a pressure difference between opposite ends of the plane in which the ball is spinning. The generation of the deviant force is perpendicular to both the axis of the spinning body and the direction of linear motion.

Vorticity

Another dynamic component that comes into play is vorticity; the formation of vortices behind a bluff body or spinning object. These vortices are disturbances or turbulences created in the medium due to the spin or flow separation imparted by the body.

Vorticity is measured in terms of the strength of the vortex generation. An easy way to visualise vorticity is the whirlpool patterns created when water rushes down a sink drain. The higher the strength, the more turbulence generated and faster the water spins. The same principle is applied to the Flettner rotors.

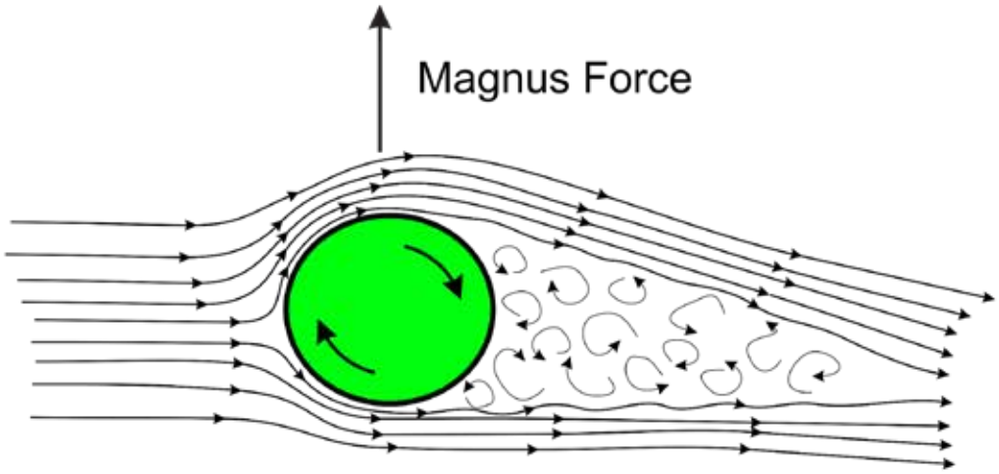
Use of rotors

Aboard a ship, the Flettner system is intended for propulsion and stabilisation. These rotor sails are powered by small motors located within the hull, while the rotors themselves project vertically upwards for propulsion. As they rotate, the Magnus effect comes into play, and a horizontal thrust is generated to the aft of the vessel.

The main source of energy are the motors that power the rotors, while the output is provided by the relative motion of the surrounding air. For maximum efficiency from Flettner rotors, the wind must flow perpendicular to the ship's length.

The faster the incoming wind, the larger the generated thrust. Ships with Flettner rotors can sail even when the wind is not in the direction the ship is headed. If the wind changes direction and approaches from the other side, the ship will move in reverse since the thrust

Photo: Enercon states that the E-Ship-1 (Loa 130.42 metres, 12,968 GT, 10,020 DWT) achieved a reduced fuel consumption of 25 per cent.



The Magnus effect (by Rdurkacz, Wikimedia).

is now generated towards the force. Thus, careful analysis of the wind direction must ensure correct heading for the vessel.

Less roll

Flettner rotors can also benefit vessel stability. While it projects vertically in the case of propulsion, the rotors extend laterally from the hull of the vessel for roll stabilisation. Located below the waterline, they measure a few metres on each side and can help with active or passive stabilisation.

In passive stabilisation, as the vessel rolls from port to starboard, the rotors are activated and begin to spin. Based on the speed and direction, they can impart either a lift or downward force on the vessel. By judging the type of force required, the roll can be stabilised by providing a righting motion using the Magnus effect. The medium in this case that provides the turbulent wake is the water flowing over the rotors. In passive rotor stabilisation, the Flettner systems on both sides of the craft rotate at the same speed in the same direction.

In the case of active stabilisation, instead of having the same characteristics, the two halves provide different lift and down forces. It is very precise and can, if properly designed, stabilise the vessel to a near standstill in even harsh weather conditions. That kind of engineering is complicated and requires a lot of experience.

Models and prototypes

Enercon, which deals in wind energy generation and technology, commissioned the E-Ship-1 in 2008 for equipment and turbine transport. According to the company, placing Flettner rotors on board helped reduce fuel consumption by 25 per cent.

Viking Line with ferry services in Finland and surrounding regions commissioned STX Europe to construct a Flettner rotor powered ship in 2011. The project was completed in 2012, but the rotors were added on the Viking Grace in 2018.

Norsepower began prototyping a practical Flettner rotor system for ocean-going vessels. The model was installed on the Maersk Pelican in 2018. It utilises a series of twin Norsepower rotors to generate cruising speeds that are said to match conventional propulsion systems.

Similarly, the bulk carrier Afros has conducted tests with a four-rotor system that has helped advance research in the design of a commercial Flettner rotor system.

For stabilisation purposes, the superyacht Eclipse, operational since 2011, uses active roll stabilisation.

Issues with the rotor

Flettner rotors are not known for their efficiency, because of the many types of transmission losses. The cylindrical rotors are a source of loss. Despite highly attuned designs to provide thrust in the right direction, the biggest drawback is that wind can blow from any direction, while the ship is supposed to move at a certain heading. Therefore, the direction of thrust varies erratically, while the propulsive power is also not constant. These are sources of inefficiency that make the Flettner system inconsistent in power generation.

> Ships with Flettner rotors can sail even when the wind is not in the direction the ship is headed

Moreover, to generate sufficient power to move a large ship with the same speed as a conventional system, rotor sails exceeding twenty metres in height are necessary. Because of the created hydrodynamic instability, the height is restricted to below fifteen metres.

By restricting the height of the rotors, their thrust is less than that of an equivalent marine diesel engine. Due to these two reasons, Flettner systems are not used commonly for propulsion.

For reasons of manoeuvrability and docking, Flettner rotors are rarely used for stabilisation.

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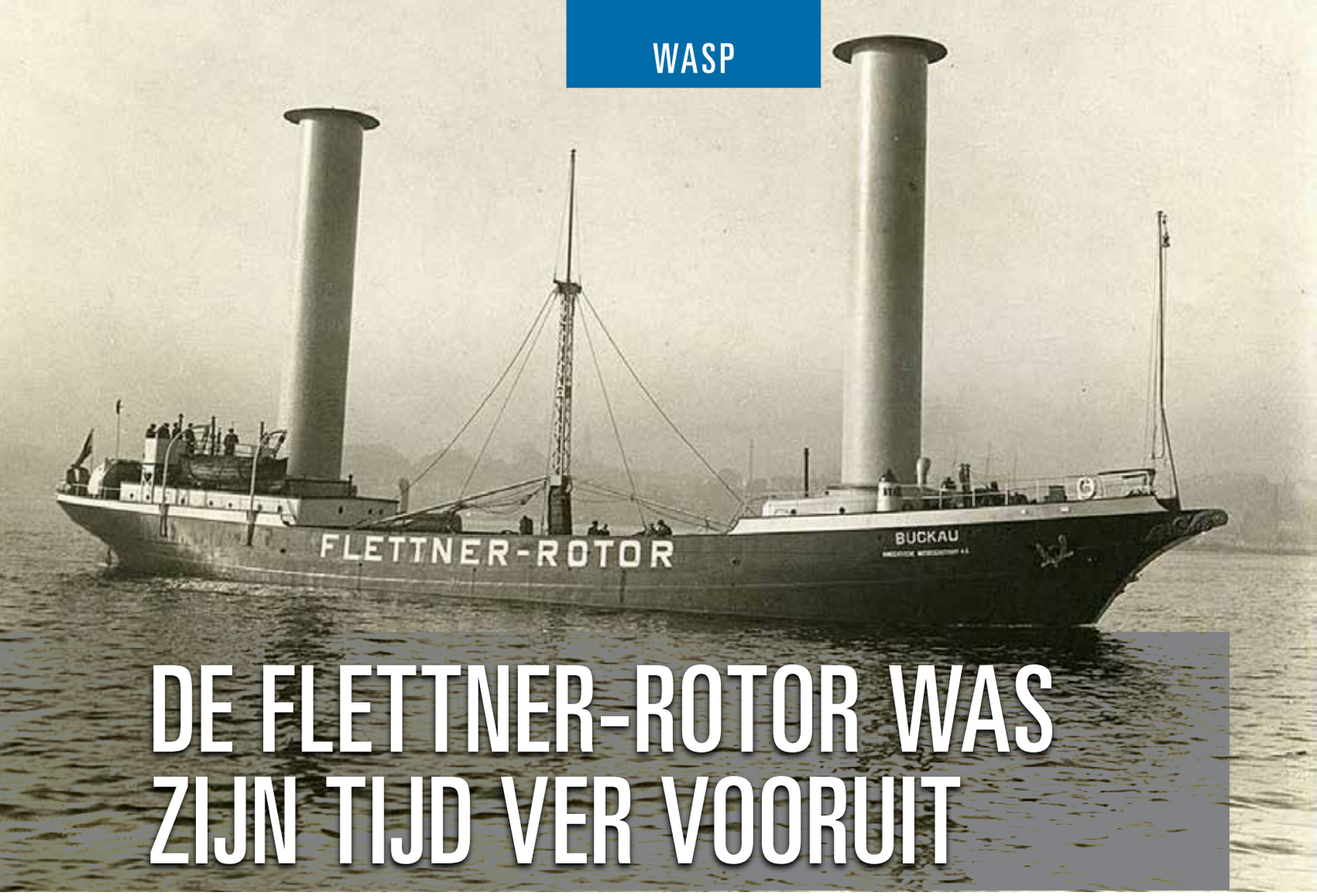


DE FLETTNER-ROTOR WAS ZIJN TIJD VER VOORUIT

Het concept van de Flettner-rotor werd bedacht door de Duitse ingenieur Anton Flettner in 1923. Zijn idee was gebaseerd op de veel vroegere doorbraak van de natuurkundige Heinrich Gustav Magnus (1802-1870) in 1851 in Berlijn. Magnus ontdekte dat een tot dan toe onbekende kracht ontstaat wanneer lucht over een roterend lichaam stroomt, het Magnus-effect. Na kennis te hebben genomen van het onderzoek van professor Ludwig Prandtl (1875-1953), directeur van het Aerodynamisch Onderzoeksinstituut in Göttingen, ontwikkelde Flettner de rotor om die te benutten voor het voortstuwen van schepen.

De nog nieuwe wetenschap van de aerodynamica voorzag Flettner van de nodige technische gegevens en overtuigde hem dat rotoraandrijving uitvoerbaar moest zijn. Ook heeft hij samengewerkt met de Finse uitvinder en architect Sigurd Savonius (1884-1931). Het idee van Flettner om windenergie te gebruiken voor de aandrijving van schepen door middel van roterende cilinders viel samen met de wederopbouw van de Duitse koopvaardijvloot na de Eerste Wereldoorlog. De Duitse reders hadden in die jaren echter geen financiële middelen voor experimenten en daarom werd de marine benaderd voor de verdere studie en ontwikkeling van rotorvoortstuwing voor schepen.

Experimenteel rotorschip

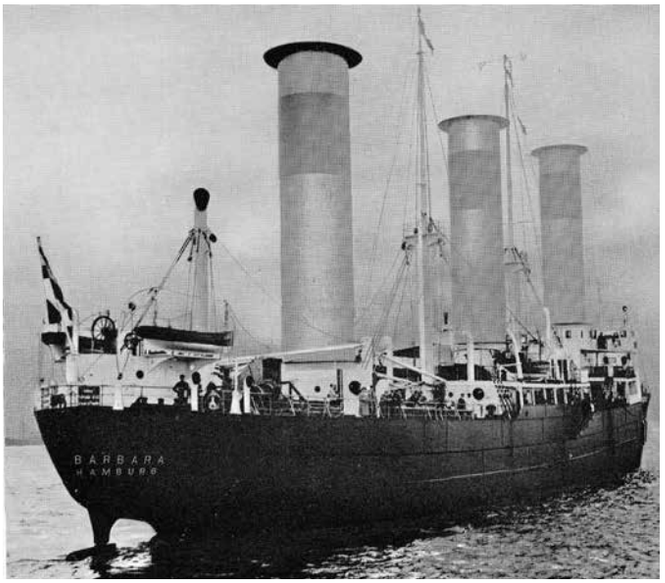
Flettner kocht de motor driemast-topzeilschoener Buckau die hij in 1924 op de Germania-scheepswerf in Kiel met twee verticaal roterende cilinders van 15 meter hoog en 3 meter in diameter liet uitrusten. Bij de ombouw tot experimenteel rotorschip werd Flettner geassisteerd door Albert Betz, Jacob Ackeret, Ludwig Prandtl en Albert Einstein. De twee cilinders werden aangedreven door twee elektromotoren met een vermogen van 20 pk (15 kW). De Buckau was daarmee het eerste schip dat met een op het Magnus-effect gebaseerd voortstuwingssysteem werd uitgerust.
De Buckau werd in oktober 1920 opgeleverd door Krupp Germania AG, Kiel, als bouwnummer 377. De tonnages waren: 497 brt, 339 nrt, 625 dwt en de afmetingen: 47,50 (45,00) x 9,00 x 4,10 (3,84) meter. Het schip werd voortgestuwd door een MAN-onderzeeboot-dieselmotor van 160 pk voor een snelheid van 7,5 knopen. De bunkercapaciteit was 12 ton en het zeiloppervlak 883 m^2.
Vanaf 7 november 1924 maakte de Buckau proefvaarten op de Oostzee. Het bleek dat het idee werkte en voldoende voortstuwings-

Foto: de Buckau was het eerste schip dat met een op het Magnus-effect gebaseerd voortstuwingssysteem werd uitgerust.

kracht genereerde om het oude zeiltuig te vervangen. De Flettner-rotor buigt de wind af naar één kant en gebruikt de resulterende krachten om het schip voort te stuwen op een vergelijkbare manier als een zeil. Maar in tegenstelling tot conventionele zeilen kunnen de rotors door één persoon alleen worden bediend. De Buckau bereikte een snelheid van ongeveer 8 knopen vergeleken met zijn eerdere snelheid van 6,5 knopen met zijn vroegere tuigage. Het schip kon beter zeilen dan normale schoeners bij matige tot zware wind. Met de 20 pk die nodig waren om de Flettner-rotors te bedienen, werd berekend dat ongeveer 1000 pk uit de wind werd gewonnen.
Op 3 december 1924 maakte de Buckau nabij Kiel op de Oostzee een demonstratievaart waarvoor het Flettner Konzern, Berlijn, Fried. Krupp AG Germaniawerft, Kiel-Gaarden, en de Hanseatische Motorschiffahrt AG, Hamburg, ruim 800 autoriteiten, reders, fabrikanten, ingenieurs en journalisten hadden uitgenodigd. Na afronding van de proefvaarten begon de Buckau in februari 1925 aan de eerste reis over de Noordzee, van Danzig naar Grangemouth. De geruisloos draaiende kolommen bleken zelfs in het stormachtigste weer te voldoen en het Flettner-rotorschip kon overstag gaan (tegen de wind in varen) bij 20-30 graden, terwijl het schip met het reguliere schoenertuigage van die tijd niet dichter dan 45 graden bij de wind overstag kon gaan.
Op 31 maart 1926 zeilde de Buckau, inmiddels overgenomen door Flettner Rotorschiffahrt GmbH, Hamburg, en omgedoopt tot Baden-Baden, via Zuid-Amerika naar New York, waar het schip op 9 mei aankwam. Op de Atlantische oversteek in 1926 gebruikte Flettners schip slechts 12 ton brandstof in plaats van 45 ton van een vergelijkbaar schip zonder rotors, een brandstofbesparing van liefst meer dan zeventig procent. Het nieuwe brandstofbesparende hulpvoortstuwingssysteem bleek aan de verwachtingen te voldoen en daarom werden de plannen voor de bouw van een tweede en groter rotorschip, de Barbara, uitgewerkt in nauwe samenwerking met en met ondersteuning van het Duitse ministerie, Flettner, AG Weser, Bremen, en de rederij Rob M. Sloman Jr., Hamburg.

Schip met drie rotors

Oorspronkelijk zouden drie schepen van gelijke grootte worden gebouwd: één met alleen motorvoortstuwing, één met alleen rotorvoortstuwing en een derde met rotors als hulpvoortstuwing. Dat zou ideaal geweest zijn en de best vergelijkbare resultaten hebben opgeleverd, maar het kon om financiële redenen helaas niet worden gerealiseerd. Alleen de Barbara, die samen met de in april en juli 1925 opgeleverde identieke motorschepen Sorrento (1878 brt, bouwnummer 395) en Amalfi (1879 brt, bouwnummer 396) door AG Weser voor Rob M. Sloman Jr. werd gebouwd, werd met Flettner-rotors als hulpvoortstuwing uitgerust.
Het rotorschip Barbara werd op 29 juli 1926 door AG Deschimag Weser, Bremen, als bouwnummer 398 opgeleverd aan de Duitse marine. Flettner leverde de plannen en berekeningen voor de rotorinstallatie van de Barbara, AG Deschimag Weser, Bremen, was verantwoordelijk voor het ontwerp en de bouw van het schip en de rederij Rob. M. Sloman Jr., Bremen zou het nieuwe schip exploiteren voor rekening van de Duitse marine.
In het oorspronkelijke ontwerp ging Flettner uit van een enkele rotor



De Barbara kreeg drie rotors, elk met een diameter van 4 meter en een hoogte van 17 meter, met een totaal windoppervlak van 204 m².

van 28 meter hoog en 7 meter in diameter. Al snel bleek echter dat deze enorme afmetingen tot onoplosbare technische problemen zouden leiden. Benodigde kogellagers of rollagers waren met de vereiste afmetingen toen nog niet beschikbaar. Daarom werd besloten tot de bouw van een rotorsysteem bestaande uit drie rotors, elk met een diameter van 4 meter en een hoogte van 17 meter met een totaal windoppervlak van 204 m². De 1,4 ton wegende rotors werden elk aangedreven door een gelijkstroommotor van 41 pk met stroomafwaartse tandwielreductie en een aandrijfas die in het draaipunt was gemonteerd. Het maximale rotortoerental bedroeg 160 omw/min, zodat een maximale omtreksnelheid van 33,5 m/s kon worden bereikt. Om gewicht te besparen, waren de rotors gemaakt van een aluminiumlegering, Lautal.

Met de twee prototypes was bewezen dat de aandrijving betrouwbaar functioneerde

Voorspelde stuwkrachtwaarden werden bereikt

De Barbara werd op 28 april 1926 in Bremen te water gelaten. Voor de hoofdvoortstuwing waren twee viertakt zes-cilinderdieselmotoren van AG-Weser/MAN (360 x 520), 2 x 530 pk bij 300 tpm, geïnstalleerd via een Vulkan-tandwielreductiekast op de schroefas die maximaal 80 omwentelingen per minuut maakte voor een dienstsnelheid van 10 knopen zonder rotorassistentie. Wanneer de wind gunstig was, konden de rotors worden ingeschakeld om een hogere snelheid te bereiken, of kon het vermogen van de dieselmotoren worden verminderd, of bij dezelfde snelheid met de Vulkan-koppe-

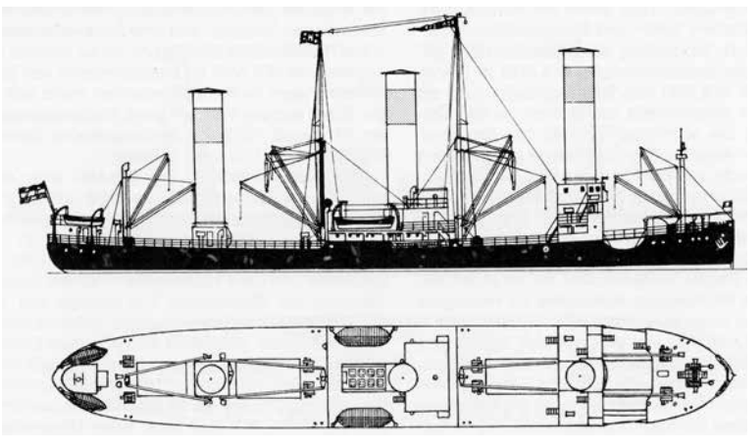
DR. ANTON FLETTNER

Dr. Anton Flettner werd op 1 november 1885 in in Eddersheim (tegenwoordig een stadsdeel van Hattersheim am Main) geboren. Oorspronkelijk was hij leraar wiskunde en autodidactisch ingenieur. Het brandstofbesparende hulpvoortstuwingssysteem, de Flettner-rotor, werd naar hem genoemd. Hij was ook bekend luchtvaartingenieur en uitvinder en leverde belangrijke bijdragen aan het ontwerp van vliegtuigen en helikopters. Flettner overleed op 76-jarige leeftijd in New York op 29 december 1961.

ling worden uitgeschakeld. Het rotorsysteem kon vanaf de brug worden bediend.

De tonnages van de Barbara waren: 2077 brt, 1010 nrt, 3050 dwt en de afmetingen: L.o.a. (l.l.) x B x H (dg) = 89,70 (85,60) x 13,20 x 5,80 (5,40) meter. De Barbara was voorzien van een Flettner-roer. Van 16 tot 29 juli 1926 werden dagelijks vanuit Bremerhaven proefvaarten uitgevoerd op de Noordzee waarbij de voorspelde stuwkrachtwaarden van de rotors volledig werden bereikt. De Barbara voer in Beaufort 4-5 met een topsnelheid van 13,5 knopen, waarbij beide motoren op volle toeren draaiden. Zonder de rotors werd een snelheid van 10 tot 10,5 knopen gehaald. Deze snelheid werd ook gehaald met één motor en alle drie de rotors bijgezet.

De rotors waren slechts bruikbaar op 25 procent van de zeedagen. De rest van de tijd konden ze niet worden gebruikt wegens te weinig wind of windstilte, ongunstige wind of manoeuvres. De Barbara werd op 30 juli tijdens de reis van Bremen naar Hamburg door de marine in ontvangst genomen en overgedragen aan Rob. M. Sloman Jr. voor zijn lijndienst naar de Middellandse Zee. Om de bemanning in te werken, werd op 3 augustus vanuit Hamburg nog een proefvaart gehouden.



Plaatsing van de rotors op de Barbara.

Doorbraak bleef uit

Met de twee prototypes was bewezen dat de aandrijving betrouwbaar functioneerde, maar een grote doorbraak bleef uit. Er volgden geen nieuwe bouwopdrachten voor rotorschepen. Brandstof was in die periode zo goedkoop dat de besparingen die de rotor opleverde voor de rederijen te gering waren om de investering snel genoeg terug te verdienen. In de daaropvolgende jaren kreeg de gehele scheepvaartsector te kampen met krimpende vrachtvolumes en steeds meer dalende vrachttarieven. De Baden-Baden werd in 1928 naar Panama verkocht en door de nieuwe eigenaar werd het schip, nadat de rotors waren verwijderd, weer als driemastzeilschoener in de vaart gebracht in de Caraïbische Zee. Het schip heeft niet lang meer gevaren. Tijdens een reis van Manuare naar Cristobal met een lading zout is de ex-Buckau op 8 november 1931 bij Cartagena gekapseisd en gezonken.

De Barbara deed dienst als vrachtschip in de lijndienst tussen Noordwest-Europa en de Middellandse Zee. Als gevolg van de grote crisis van 1929 en de daaropvolgende malaise in de wereldhandel, gaf Sloman de Barbara op 28 mei 1931 terug aan de eigenaar, de Deutsches Reich Marine-Verwaltung. De Barbara werd uit de vaart genomen en opgelegd. Omdat er geen mogelijkheid was om het rotorschip in de toekomst nog kostendekkend te vercharteren, werd de Barbara te koop aangeboden. In oktober 1933 is het schip als Birkenau verkocht aan Bugsier AG, Bremerhaven, die een nieuwe brug midscheeps liet plaatsen, de drie rotors ontmantelde en alleen de motoren gebruikte.

> Door de nieuwe milieueisen lijkt er alsnog een toekomst voor deze uitvinding weggelegd

De geschiedenis van het rotorschip was voorlopig ten einde. Het schip zelf overleefde de oorlog en bleef nog onder drie vlaggen tot augustus 1978 in de vaart. Rotorhulpvoortstuwing is bijna negentig jaar geleden geen commercieel succes geworden. Door de nieuwe milieueisen en nadat het brandstofverbruik werd gerelateerd aan de emissies van rookgassen lijkt er alsnog een toekomst voor deze uitvinding weggelegd.

Gerrit de Boer
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REDERS MOETEN CO_2-KNOOP NU DOORHAKKEN

SMM Digital belicht koolstofneutrale opties

Om de CO_2-emissies met gemiddeld veertig procent per schip te laten dalen in 2030 en met vijftig procent voor de sector als geheel in 2050, moeten reders nu knopen doorhakken over de bouw van emissieloze opvolgers voor aan vervanging toe zijnde schepen. Rekening houdend met ontwerptijd, nieuwe regels en alle certificeringen, zou de eerste generatie CO_2-neutrale cruise- en handelsschepen rond 2030 operationeel kunnen zijn.

Dat beeld werd geschetst tijdens het online gepresenteerde "Global maritime environmental congress" (gmec), tijdens het van 2 tot 5 februari gehouden "SMM Digital 2021". Laatstgenoemde evenement verving de wegens corona afgelaste "Messe für Schiffbau, Maschinen und Meerestechnik" (SMM) in Hamburg.

'We willen de IMO-doelstelling voor 2050 al in 2040 bereiken,' stelde Hansjörg Kunze, Vice President Communication & Sustainability van AIDA Cruises tijdens het congres. 'Dit is dan een goed jaar om te beginnen, want tussen ontwikkeling en eerste vaart van een cruiseschip zit een lange periode.'

Als voorbeeld van zo'n lange periode noemde Kunze de ontwikkeling en bouw van cruiseschepen met walstroominstallaties, waarvoor AIDA in 2004 opdracht gaf aan de Meyer Werft. 'In 2015 legde het eerste cruiseschip met walstroom in Hamburg Altona aan, twaalf jaar later.'

Inmiddels zijn alle AIDA-schepen min of meer geschikt voor walstroom, maar is die in veel havens nog altijd niet leverbaar. 'Pas nu komen er meer havens in Duitsland met goedgekeurde walaansluitingen,' aldus Kunze. 'Maar wij moesten hierover al in 2004 een besluit nemen.'

Hetzelfde patroon was zichtbaar bij de ontwikkeling van de eerste generatie LNG aangedreven cruiseschepen van AIDA. 'Wij moesten al jaren voor de discussie over gebruik van LNG begon een beslissing nemen over de ontwikkeling en bouw,' zei Kunze. 'Ver voor we definitief toestemming kregen om LNG te mogen gebruiken. Er was veel discussie over de inbouw van de dual-fuel-installatie en het bunkeren van LNG. Of alle passagiers niet van boord moesten bijvoorbeeld. Voor het krijgen van definitieve toestemming om LNG in de haven te bunkeren met passagiers was een stapel documenten van 10 meter hoog nodig.'

Inmiddels zet de cruiserederij de volgende stap. 'We testen nu een brandstofcel op de AIDAnova, met steun van de Duitse overheid. Die draait op methanol.' Kunze kan zich voorstellen dat de brand-

Foto: het model van de door de Meyer Werft gebouwde AIDAnova trok op de SMM 2018 veel aandacht. Het dat jaar in de vaart genomen cruiseschip is het eerste LNG aangedreven cruiseschip en heeft ook een walstroominstallatie. Het is 55 procent energiezuiniger per passagier dan de vorige generatie cruiseschepen (foto Hans Heynen).

stofcellen met batterijen, windaandrijving, zonnecellen, biobrandstof en e-fuels straks worden gecombineerd om tot een CO_2-neutrale voortstuwing te komen. 'We bekijken alle mogelijkheden en hebben diverse pilots uitgevoerd. Maar de finale oplossing is nog niet gevonden, we hebben nog geen definitieve beslissing genomen.'
Wanneer de definitieve keuze is gemaakt, zal het verkrijgen van de benodigde certificeringen, documenten en toestemmingen de nodige voeten in de aarde hebben. 'Zelfs met een superwerf als Meyer duurt het lang voor je alles voor elkaar hebt,' aldus Kunze. 'Het gaat stap voor stap en samenwerking is daarbij belangrijk. Alleen red je het niet en we willen een toekomstbestendige cruisebusiness ontwikkelen. Onze gasten willen dat we in de fjorden kunnen blijven varen. Dan zijn grote accupakketten nodig, brandstofcellen en hernieuwbare energie. We willen voorop lopen als cruiseindustrie en misschien is in 2030 het eerste CO_2-neutrale cruiseschip al klaar.'

Hansjörg Kunze (AIDA Cruises): 'We bekijken alle mogelijkheden en hebben diverse pilots uitgevoerd. Maar de finale oplossing is nog niet gevonden, we hebben nog geen definitieve beslissing genomen.'

DFDS mikt op energie 2.0

Jakob Steffensen, hoofd innovatie en technologie bij de Deense ferry-, ro-ro- en containerrederij DFDS legde tijdens het webinar de focus op "energie 2.0" om van fossiele brandstof af te komen. Om de emissies van de DFDS-vloot te verminderen, wil Steffensen nieuw te bouwen schepen meteen uitrusten met CO_2-neutrale voortstuwingsinstallaties en bestaande schepen voorlopig op fossiele brandstof laten varen. Aantrekkelijkste klimaatneutrale brandstoffen voor de scheepvaart zijn volgens Steffensen hernieuwbare ammoniak en waterstof. 'Dat zijn volledig koolstofvrije brandstoffen. We hebben ook naar koolstofhoudende hernieuwbare brandstoffen gekeken, zoals methanol, maar we verwachten dat sectoren die geen andere optie hebben, zoals de luchtvaart, bereid zijn meer te betalen voor hernieuwbare koolstofhoudende brandstof. Wij zien daarom ammoniak en waterstof als financieel meest zinvolle brandstoffen voor de scheepvaart.'

> Groene waterstof en ammoniak zien wij als goed opschaalbare brandstoffen voor de scheepvaart

Ammoniak verstandige keus voor scheepvaart

Scheepvaartondernemingen als DFDS (en Maersk) maken in Denemarken deel uit van een klimaatpartnerschap met onder andere industrie, agrarische sector, luchtvaart, wegtransport, cementproducenten en energiebedrijven. 'Daar wordt overlegd over manieren waarop Denemarken in 2030 een CO_2-reductie van zeventig procent kan bereiken,' zei Steffensen. 'Dan blijkt dat luchtvaart en cementindustrie in grote problemen komen wanneer ze niet alle in de toekomst in Denemarken te produceren duurzame koolstof kunnen gebruiken. Het partnerschap heeft gekeken hoe een waterstoffabriek bij Kopenhagen eruit zou kunnen zien, die met windenergie waterstof maakt. Wanneer we daarbij duurzame koolstof maken uit CO_2, kunnen we in Denemarken 800.000 ton hernieuwbare methanol per jaar produceren. Wanneer dat allemaal naar de luchtvaart gaat, is het net genoeg om één derde van de vliegtuigen die uit Kopenhagen vertrekken van brandstof te voorzien.'
Hoewel Stena met de op methanol varende Stena Germanica heeft aangetoond dat het mogelijk is, kan de sector dus beter op andere hernieuwbare brandstoffen inzetten. 'Groene waterstof en ammoniak zien wij als betere en goed opschaalbare brandstoffen voor de scheepvaart,' stelde Steffensen. 'Ze zijn te produceren uit wind, zon en water, elementen die ruim voorradig zijn en bij verbranding komt

Jakob Steffensen (DFDS): 'Wanneer je nieuwe schepen meteen op ammoniak of waterstof laat varen of bij de bouw al daarvoor geschikt maakt, zet je in één keer de stap naar CO_2-vrij.'

geen CO_2 vrij. Wanneer je nieuwe schepen meteen op ammoniak of waterstof laat varen of bij de bouw al daarvoor geschikt maakt, zet je in één keer de stap naar CO_2-vrij. Met ammoniak krijg je daarbij een motorconfiguratie die vergelijkbaar is met de huidige motoren. Waterstof is in combinatie met brandstofcellen (en batterijen) ook een grote stap.'

Waterstof ziet de Deen daarbij vooral als optie voor schepen die op kortere vaste routes varen en ammoniak voor schepen die op langere trajecten varen. Op bestaande schepen zou een omschakeling haalbaar zijn wanneer de motoren toch al aan vervanging toe zijn. 'Dan zijn de meerkosten overzichtelijk,' aldus Steffensen.

Snelle vooruitgang

DFDS heeft met een aantal partners Europese steun aangevraagd voor de ontwikkeling van een op waterstof varende emissieloze veerboot op de route Oslo-Kopenhagen. 'Op dit moment hebben we nog geen besluit genomen over het soort brandstofcellen dat we daarvoor willen gebruiken', vertelde Steffensen. 'Bedoeling is dat het systeem ook op andere veerboten gebruikt kan worden.' DFDS onderhoudt een groot aantal veerdiensten in Europa. Hoewel er nog een lange weg te gaan is, zijn er volgens Steffensen hoopvolle ontwikkelingen in de goede richting. 'In 2016 zaten we met technische commissies van diverse Deense maritieme bedrijven om de tafel en keken naar CO_2-neutrale brandstoffen als methanol, biodiesel, bio-LNG en e-fuels, maar ook naar volledig CO_2-vrije brandstoffen, zoals waterstof en ammoniak. Voor die brandstoffen was toen nog geen enkele infrastructuur. Wanneer je ziet hoe snel daarmee vooruitgang is geboekt in vier jaar, stemt dat optimistisch.'

> De consument kan vergroening van de scheepvaart stimuleren door erom te vragen

Urgentie ontbreekt

Arnaud Boehmann, woordvoerder van de Duitse maritieme milieuorganisatie FridaysForFuture vond juist dat de scheepvaartsector veel te weinig doet om de CO_2-emissies te verlagen. 'De scheepvaart heeft jarenlang financieel geprofiteerd van de lakse milieuwetgeving, waardoor ze op industrieel afval konden varen. De sector draagt daardoor een bijzondere verantwoordelijkheid. Het IMO-doel om de CO_2-emissies in 2050 met vijftig procent te verminderen schiet catastrofaal tekort. Dat is een bankroetverklaring wanneer in Parijs is afgesproken dat de uitstoot dan wereldwijd nul moet zijn.'

Er zijn volgens Boehmann oplossingen mogelijk om de scheepvaart volledig te 'decarboniseren'. 'Net als bij het wegvervoer zal het niet om één oplossing gaan. Synthetische brandstof, groene waterstof, batterijen en wind moeten op de vraag van de verschillende scheepstypen worden toegesneden. De mensheid heeft zijn waren duizenden jaren met windkracht over het water vervoerd. Natuurlijk kan je de grote containerschepen niet zomaar ombouwen tot windjammers, maar wind gaat zeker een rol spelen in de toekomst van de scheepvaart. De staat moet het onderzoek en de ontwikkeling van CO_2-neutrale aandrijvingen stimuleren. Uiteindelijk zullen reders, handelaren, overheid en consumenten samen de kosten moeten dragen, maar dat zal de moeite lonen.'

Volgens Boehmann zit er een gat tussen de ambities van de scheepvaartindustrie en de milieubeweging. 'Wij waarderen de mensen die daar nu iets doen wat ze tien jaar geleden nog niet deden, dat is vooruitgang. Maar we zien niet de urgentie van de coronabestrijding bij de decarbonisatie van de scheepvaartindustrie en dat zou wel moeten.'

Meer promotie nodig

Lars Robert Pedersen, adjunct-secretaris-generaal van BIMCO, beaamde dat de CO_2-emissies zo snel mogelijk moeten dalen. 'Maar de industrie moet wel winstgevend blijven. Hoe moeten de nieuwe schepen straks naast de oude varen,' vroeg hij zich af. 'De transitie duurt zeker twee decennia. Hoe moeten die schepen in dezelfde markt concurreren wanneer de kosten zo sterk uiteenlopen? Het zijn fundamenteel verschillende schepen.'

Een probleem is volgens Pedersen ook dat de meeste mensen niet weten hoe belangrijk de sector is en hoe de scheepvaart werkt. 'De consument ziet niet wat wij allemaal aan grondstoffen en eindproducten vervoeren. De schepen varen over zee en zijn onvindbaar voor de wereldbevolking. Er is meer promotie nodig. In de supermarkt, waar de consument producten koopt, ziet hij of zij ons niet. Dat kennisgat moeten we vullen. We kunnen daar niet tien jaar mee wachten.'

Scheepvaartdeskundige Sönke Diesener, van milieuorganisatie NABU denkt niet dat consumentenbelangen een vergroening in de weg staan. 'Wanneer iedereen drie cent in plaats van één cent voor het transport van een T-shirt betaalt, kun je al schoon vervoeren. De consument kan vergroening van de scheepvaart stimuleren door erom te vragen. Een CO_2-belasting helpt ook. Voor winstgevendheid moeten we de normen niet verlagen,' stelde hij tijdens het webinar.

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LNG FUEL AND METHANE SLIP

Big steps taken by engine manufacturers, but methane slip remains an issue

Apart from LNG carriers, there are now some 250 merchant ships sailing on LNG or CNG and their numbers are increasing. Presently, more than 100 such ships are on order, including large cruise and container ships. The main non-economic reasons for using natural gas are reduced emissions. Yet, it also has a disadvantage: the so-called methane slip, the leaking of methane, a very strong greenhouse gas (GHG), into the atmosphere due to incomplete combustion or otherwise. This issue will be discussed in this article.

Ships are powered by diesel engines, not all of them, but a very large majority. This is still the case in 2021. Most of these engines operate on a liquid oil based fuel such as low sulphur fuel oil (LSFO), heavy fuel oil (HFO), marine diesel oil (MDO) or marine gas oil (MGO). So far, the alternative fuel most used for ships is natural gas. Initially only on LNG carriers, taking the fuel as boil-off from the cargo. But for a number of years now, other ships also bunker natural gas, either as LNG (liquid natural gas) or as CNG (compressed natural gas) and use it as the fuel for their engines. And these numbers are increasing. Meanwhile, it is possible to bunker LNG in approximately 150 ports around the world. Using natural gas lowers CO_2, SO_2 and PM emissions when compared with using traditional fuels. CO_2 emissions are some twenty to 25 per cent lower than those of oil fuels.

Short history of engines running on gas

Engines running on gas have been used on shore for many years, mainly for power stations. Since the seventies of the last century often in co-generation installations such as for agriculture and hospitals, combining the production of electricity and heat, with powers up to 10 MW per engine. Most of these engines are Otto engines in which a compressed air-gas mixture is ignited by a spark plug. Since the beginning of this century, systems have been developed to enable the use of natural gas as a fuel for internal combustion

Photo: The Willem de Vlamingh is one of two new (single-fuel) LNG-powered ferries of Rederij Doeksen (by Flying Focus).

engines on ships. The fuel is stored as LNG on board in liquid form in insulated tanks at about -160°C or compressed as CNG in cylindrical tanks at a pressure of for example 200 bar. Gas and dual-fuel engines work either according to the Otto or the Diesel principle. There are pure gas engines (SG – spark gas), which work according to the Otto principle, dual-fuel (DF) engines using the Otto principle and dual-fuel engines using the Diesel principle (GD – gas-diesel). In a pure gas engine, a mixture of air and gas is compressed and ignited by a spark plug mounted in the cylinder head (SG engines). In a dual-fuel engine, the compressed mixture of air and gas is ignited by injecting a liquid pilot fuel (diesel oil or HFO) under high pressure into the cylinder (DF engines). In dual-fuel engines using the Diesel principle, only air is compressed in the cylinder whilst just before the piston reaches its top position, gas under high pressure is injected into the cylinder and this gas-air mixture is ignited by injecting a pilot fuel of diesel oil or HFO (GD engines).

In 2001, the Norwegian ferry Glutra became the first ship with diesel engines operating on natural gas, with Mitsubishi four-stroke gas engines of 675 kW at 1500 rpm. Most major builders of marine engines have meanwhile introduced engines operating on natural gas. Four-stroke engines of all three types (SG, DF and GD) are available, two-stroke engines either as DF or GD types. The medium speed four-stroke engines operate in general with low pressure of the air-

GLOBAL WARMING POTENTIAL

Global Warming Potential (GWP) is the heat absorbed by any GHG in the atmosphere, as a multiple of the heat that would be absorbed by the same quantity of carbon dioxide (CO_2). GWP is 1 for CO_2. For other gases, it depends on the gas and the timeframe. Some gases, like methane, have a large GWP, since a tonne of methane absorbs much more heat than a tonne of CO_2. Other gases, again like methane, break down over time, and their heat absorption, or GWP, over the next twenty years is a bigger multiple of CO_2 than their heat absorption will be over 100 or 500 years. Values of GWP are estimated and updated for each time frame as methods improve. For methane, the GWP for a 100-year period according to the Fifth Assessment Report from the IPCC (Intergovernmental Panel on Climate Change) is estimated as 28. For nitrous oxide (NO_2) and Hydrogen (H_2), the GWP is 298 and 4.3 respectively. For so called high-GWP gases as chlorofluorocarbons (CFCs), the GWP figures may be much higher, in the thousands or tens of thousands.

Engine typea	Example ship types (and engines)	Ships in operation and on order as of mid-2018[b]	Year with the most installations[b]	Thermal efficiency when using LNG[c]	Methane slip (gCH_4/kWh)	Included in our analysis?
LBSI, medium-speed	Car/passenger ferries mostly (e.g., Rolls-Royce/ Bergen C26:33L9PG), offshore supply vessels (OSVs), a few general cargo, tugs, and roro vessels	At least 45	2014	48%	4.1	No; has few international shipping or cruise ship applications
LPDF, medium-speed, four-stroke	LNG carriers mostly (e.g., Wärtsilä 12V50DF) with some OSVs and car/ passenger ferries; also used for LNG-fueled cruise ships (e.g., MaK 16M46DF)	At least 300, including at least 13 cruise ships	2018	48%	5.5	Yes; has current and future international shipping and cruise ship applications
LPDF, slow-speed, two-stroke	LNG carriers (e.g., Wärtsilä/ Winterthur Gas & Diesel (WinGD) 5X72DF) and mega container ships (e.g., Wärtsilä/ WinGD 12X92DF). Also, some oil and chemical tankers	At least 50	2020	50%	2.5	Yes; has current and future international shipping and cruise ship applications
HPDF, slow-speed, two-stroke	LNG carriers (e.g., MAN- B&W 5G70ME-C9-GI) as well as container ships and a few car carriers, general cargo carriers, and a bulk carrier	At least 90	2018	53%	0.2	Yes; has current and future international shipping and cruise ship applications
Steam turbine	LNG carriers (e.g., Kawasaki UA-400)	At least 280	2006	28%	0.04	No; has limited future international shipping applications and is an older and less efficient technology compared with other LNG engines
Gas turbine	High-speed ferries (e.g., GE LM2500)	At least 1	2013	37%	0.06	No; has limited, if any, international shipping or cruise ship applications and is less efficient than other LNG engines

a LBSI means lean burn spark-ignited; LPDF means low-pressure injection, dual fuel; HPDF means high-pressure injection, dual fuel.
b Source: IHS (2019).
c For dual-fuel engines, thermal efficiency can be slightly lower when using conventional marine fuels.

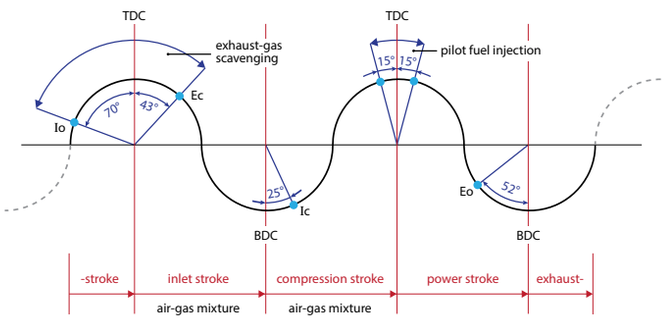
Table 1. LNG engines, the ships that use them, and their methane slip emission factor assumptions (by IHS).

Fjord Line's MS Stavangerfjord was built by Bergen Group Fosen in 2013 and is one of the largest cruise ferries in the world to be run entirely on LNG (photo Fjord Line/ Espen Gees).

gas mixture. Two-stroke crosshead engines operate either with low fuel gas pressure (up to 10 bar) or high fuel gas pressure, for instance 300 bar, provided by multi stage compressors.

Features of burning LNG compared with HFO

Advantages of burning LNG are no sulphur emissions, lower NO_X emissions (particularly for engines operating with low gas pressure), 95 per cent reduced particle emissions (PM) and about 25 per cent lower CO_2 emissions. Natural gas contains about 82 to 92 per cent methane and some other hydrocarbons, like ethane, butane, pentane and hexane and fourteen per cent nitrogen and small quantities of oxygen and CO_2. LNG contains almost only methane, the remaining gases and hydrocarbons have been removed during the liquefaction process.



Inlet stroke	70 + 180 + 25 = 275°	Low pressures: long processes (inlet/exhaust)
Compression stroke	65 + 90 = 155°	High pressures: short processes (compression/power)
Power stroke	90 + 38 = 128°	
Exhaust stroke	52 + 180 + 43 = 275°	
Pilot fuel injection	15 + 15 = 30°	
Exhaust-gas scavenging	70 + 43 = 113°	

Figure 1. A continuing crank movement graph of a four-stroke dual-fuel engine, with pilot fuel injection ignition.

Methane slip is the quantity of methane that does not burn in the engine and is released into the atmosphere. Methane is a GHG with a much higher Global Warming Potential than CO_2 (see text box).

What causes methane slip in engine installations?

Table 1 provides an overview of the type and make of gas and dual-fuel engines presented by IHS in 2019. The number of LNG fuelled ships in operation and on order has meanwhile increased considerably.

Methane slip is the release of unburnt methane into the atmosphere. In engines operating according to the Diesel principle, injecting the fuel into a cylinder with compressed air and igniting it with a pilot fuel, the combustion takes place in a diffuse and heterogeneous environment. With this process, the release of unburnt methane together with exhaust gases is very limited. The combustion is nearly perfect.

However, in engines operating on the Otto principle, igniting a compressed and homogeneous mixture of air and gas by a pilot fuel or spark plug, the combustion is less perfect with small quantities of methane being released into the atmosphere with the exhaust gases. This is primarily being caused during the exhaust gas scavenging (see figure 1) and through incomplete combustion of the mixture at certain spots in the cylinder, such as shown in figure 2.

Reducing the level of methane slip

The level of methane slip, or rather the total quantity of hydrocarbons being released (THC: total hydrocarbon emissions), depends on the combustion process of the engines operating on natural gas. The burning of natural gas in the cylinder of an engine requires a high quantity of air and a low combustion temperature in order to reach the maximum engine efficiency and as low as possible emissions of NO_X. However, methane burns more completely at higher temperatures, which means that gas at relatively cold spots, such as at the cylinder liners, may leave the engine unburnt. Engine designers try to reduce that effect by limiting these cold cylinder liner areas as much as possible. Furthermore, minimising the size and number of small spaces in the cylinder, such as above piston rings,

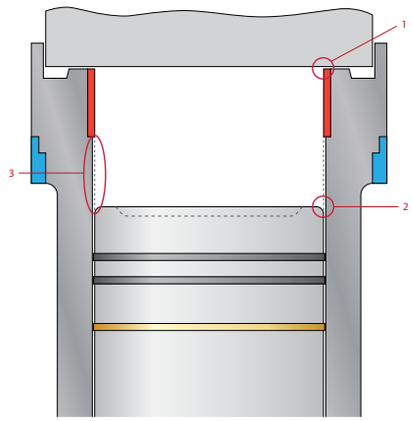


Figure 2. Drawing of a cylinder of an Otto engine indicating the spots where combustion may not be optimal.

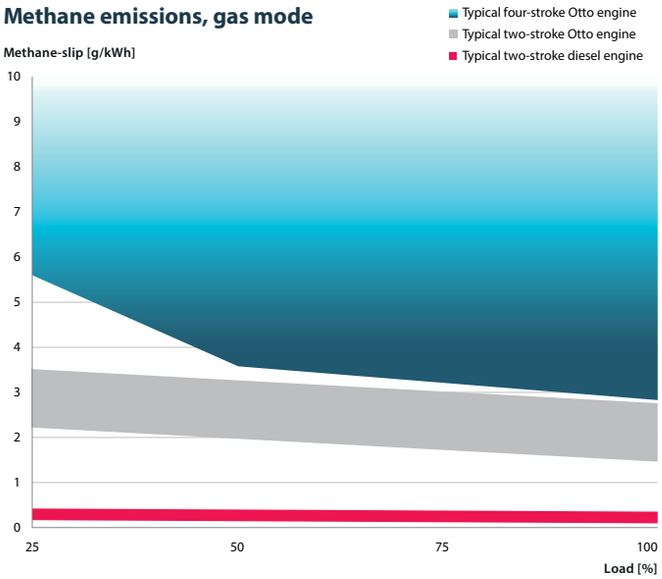


Figure 3. Methane emissions in gas mode – comparison of different engine types (taken from a document of MAN Energy Solutions).

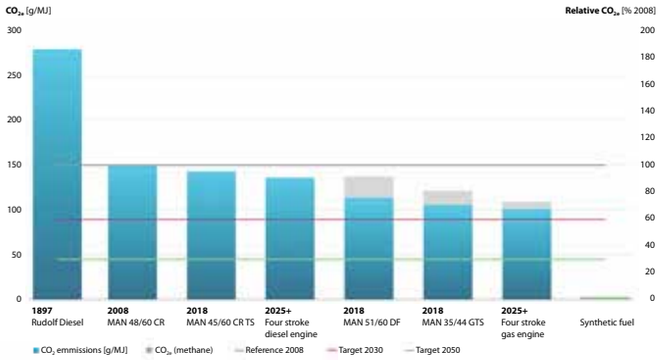


Figure 4. Comparison over time of CO_2 emissions from different types of MAN four-stroke engines – how low can it go?

may help to keep methane slip as small as possible.
Nowadays, in most engines anti-polishing rings are being used, which help against methane slip. Anti-polishing rings are installed in the upper end of the cylinder in order to remove deposits from the piston top land and ensure proper cylinder function, no bore polishing, stable lube oil consumption and low liner wear.
The timing of the gas injection and the duration of the exhaust gas scavenging phase, during which both the inlet and outlet valves are open, are other important points of attention. The scavenging phase is used to cool the hot parts of the combustion chamber, minimising the formation of NO_X, and to remove exhaust gases still present in the cylinder. Cooling of the parts of the combustion chamber increases methane slip. By optimising the motor management system and valve operation, this effect can be limited.

Over the last ten years, methane slip of Otto engines has been reduced by some 65 per cent

Presently, it is being investigated whether the addition of a small quantity of hydrogen to the combustion process could be another way to reduce methane slip. The hydrogen would improve the combustion process, reducing methane slip. Unfortunately, the addition of hydrogen results in higher combustion pressures and temperatures, which could lead to allowed NO_X emission limits being exceeded.
Over the last ten years, methane slip of Otto engines has been reduced by some 65 per cent. To reduce methane slip of such engines further, an EGR (exhaust gas recirculation) system or an SCR (selective catalytic reduction) system is necessary. The same solution could be applied to engines working on the Diesel principle to limit the NO_X emissions in order to comply with the Tier III emission rules. Above measures were very effective with dual-fuel engines used on land, such as in power stations. Engine manufacturer Wärtsilä has installed in total 2 gigawatt of these engines on land and claims a methane slip of about 1g/kWh. For installations on ships, Wärtsilä expects the same figures for these engines as of 2022, also when converting existing engines for gas operation (retrofit installations). Figure 3 shows methane emissions in gas mode.

Some typical examples

- **Wärtsilä:** Dual-fuel, low pressure, medium speed four-stroke engines. The level of methane slip has been reduced by some 75 per cent over the past 25 years. Further reductions are expected according to the manufacturer, aiming at a level of 1g/kWh. The methane slip of a Wärtsilä type 46 DF marine engine is presently in the order of 2.8 g/kWh.
- **MAN Energy Systems:** Two-stroke, dual-fuel engines, type ME-GI, employing the Diesel process. For these engines, MAN guarantees methane slip levels in a range from 0.2-0.3 g/kWh over the engine's load range. For its four-stroke engines, MAN claims to have halved methane slip over the last ten years, and sees a seventy per cent reduction potential through aftertreatment solutions and ninety per cent through direct gas injection technology as used on ME-GI two-stroke engines.
- **Winterthur Gas & Diesel (WinGD):** Two-stroke, crosshead, low pressure X-DF engines. Operating on the lean-burn Otto cycle. According to WinGD, with this engine, CO_2 emissions are reduced by 25 to thirty per cent compared with propulsion systems running on residual fuels. By taking into account the methane

slip of these engines, the overall CO_2 equivalent emission reduction is in the order of fifteen to twenty per cent. The methane slip level may be reduced by some fifty per cent through the application of the Alfa Laval "Pure Cool" system. With this system, about fifty per cent of the exhaust gases are being cooled and recirculated through the engine. This does not only reduce the methane slip, but also the fuel consumption by about three per cent.

Regulations

Presently, there are no IMO regulations for the allowable methane slip level for marine installations, perhaps these will be introduced in 2023. The European regulations for the maximum allowable methane slip of engines of road trucks are:

- Euro IV: 1.6 g/kWh
- Euro V: 1.1 g/kWh
- Euro VI: 0.5 g/kWh

Conclusions

The Diesel process results in less methane slip, but requires a costly high pressure gas injection system. The Otto process gives more methane slip, but the low pressure gas system is cheaper and simpler. Manufacturers are actively working to lower the methane slip levels of their engines, so far with good results. But it remains an important issue. Nevertheless, the use of natural gas as a marine fuel, either as LNG or CNG, provides a useful contribution to the reduction of GHG emissions from shipping, at least for the short and medium term. When in future gas from either bio-sources or power-to-gas sources can be mixed at any rate, a gradual transition from fossil fuels to renewable fuels would be possible.

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NIEUWE UITGAVEN

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Canon van de Koninklijke Marine

In "De Canon van de Koninklijke Marine" beschrijven Dr. Anne Doedens (docent Nieuwe geschiedenis hbo in Amsterdam) en Vice-admiraal b.d. Matthieu J.M. Borsboom in vijftig vensters (hoofdstukken van vier pagina's) thematisch en voor zover mogelijk chronologisch de geschiedenis van de Nederlandse zeemacht.

Het is een geschiedschrijving in beperkte omvang, geen compleet en volledig overzicht en meer te beschouwen als een wegwijzer en kompas in de omvangrijke geschiedenis van de marine vanaf 8 januari 1488, toen de Habsburgse keizer Maximiliaan II de Ordonnantie op de Admiraliteit afkondigde. Vanaf die datum was er sprake van een georganiseerde zeemacht zowel ten tijde van de Republiek als van het koninkrijk Nederland tot nu. De auteurs van dit overzichtswerk hebben dit gedaan aan de hand van vijftig gedenkwaardige onderwerpen. Niet alleen over zeehelden of zeeslagen, maar ook thema's over de geuzen, kapers, slavernij en wapens komen aan de orde. Roemruchte onderdelen van de marine worden belicht, van het optreden van de mariniers 'zo wijd de wereld strekt', tot de operaties van de vloot, de Kustwacht en de Mijnen-, Marine Luchtvaart- en Onderzeedienst. Van acties voor de Nederlandse kust tot in verre streken zoals Nederlands Oost-Indië, hoogte- en dieptepunten, personen, overwinningen en nederlagen, technologische vernieuwingen zoals de modernisering van zeil naar stoom tot in het tijdperk van de automatisering. Verder is ook aandacht besteed aan bekende zeeschilders: van Willem van de Velde de Oude en zijn zoon Willem van de Velde de Jonge en Ludolf Bakhuizen tot hun collega's in deze tijd, waaronder Jan de Quelery. Per venster is een beschrijving, een geciteerde tekst en een *lieu de mémoire* (plaats om te herinneren, locaties die bezocht kunnen worden) met adresgegevens en verwijzingen naar websites opgenomen. Een overzichtelijke en zeer toegankelijke uitgave met een index van eigennamen van personen, schepen, plaatsen en begrippen voor iedereen die geïnteresseerd is in de maritieme geschiedenis van Nederland. Een ware reis door de geschiedenis van de Koninklijke Marine en bovendien mooi uitgevoerd met vele fraaie illustraties.

De Canon van de Koninklijke Marine – Geschiedenis van de zeemacht, formaat 23,5 x 28 cm, 224 pagina's, afbeeldingen, ISBN 9789462494879, Walburg Pers, Zutphen, prijs € 29,99, of als eBook ePub € 14,99, info: www.walburgpers.nl

ALWAYS KEEP A SHARP LOOKOUT

Mariners' Alerting and Reporting Scheme

Unsafe safety lines: Mars 202108

A pilot brought a large bulk carrier alongside. Once berthed, he descended to the main deck for disembarkation. The crew were in the process of rigging the gangway, which was now swung out and some 15 metres above the wharf. The pilot saw two crew members on the gangway with safety harnesses on, but the safety lines from the harnesses to the ship were not secured to a strong point. Instead, they were being held in the hands of other crew members on deck. All of the safety lines appeared in poor condition (see photo) and would probably have failed if any load had come on the line.

The pilot immediately protested to the chief officer and master and corrections were made. The issue was reported to the local maritime safety authority as a safety and crew competence issue.

All of the safety lines appeared in poor condition.

Lessons learned

- Every mariner has a duty to report unsafe conditions. In this case, a pilot spotted some obvious unsafe conditions and made a proper report to vessel and shore authorities.

Close call with a submarine: Mars 202109

As edited from MAIB (UK) report 13/2020

A fast ferry was underway at near 21 knots when the lookout saw a submarine periscope at close range on the port bow. He immediately alerted the officer of the watch (OOW), who observed from the periscope's wake that the submarine was crossing the ferry's bow from port to starboard. Given this information, and assessing that there was an imminent risk of collision, the OOW told the lookout to take hand-steering and to apply 10° of port rudder. Further port rudder was put on shortly afterward to increase the closest point of approach (CPA) from the periscope. The

Submarine periscope as seen from ferry.

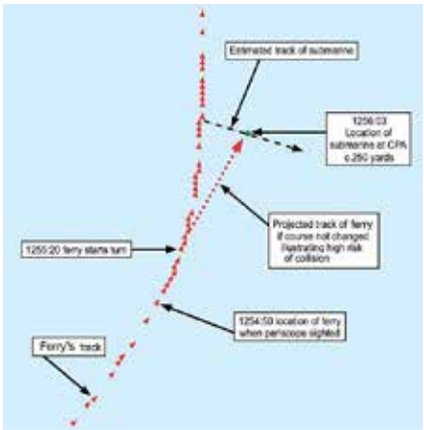
OOW alerted the master, who came to the bridge immediately. About 45 seconds later, with the submarine's periscope passing close to starboard at about 6 knots, the ferry was brought to a steady heading.

Investigation findings

As it turned out, the submarine's command team had made several errors that each contributed to the close quarters situation. The approach speed of the ferry was underestimated (taken as 15 knots instead of 21) and the ferry's range was overestimated. Both of these errors contributed to another critical error on the part of the submarine's command team to remain at periscope depth instead of deep diving out of harm's way.

Lessons learned

- This close call illustrates the importance of keeping a sharp lookout. Had the ferry's lookout not spotted the periscope, a high speed collision with the submarine was a distinct possibility.
- Turning to port to avoid a collision with another vessel on your port side is usually not the best choice of manoeuvres, but given the speed of closure between the two vessels in this instance (27 kts), their respective positions and the good visibility, it proved to be the right one.



The schematic track of both the ferry and submarine shows that this was a very close call.

Negative pressure in cargo tanks: Mars 202111

In the early morning hours, a tanker docked to commence unloading. Contrary to port procedures and best practices, there was a negative pressure in the cargo tanks of about 270 mm/wg. This was corrected by the addition of inert gas from the inert gas system (IGS) before unloading commenced. Unloading then proceeded without incident and once empty, the vessel departed.

Investigation findings

The company investigation found, among others, that during the vessel's approach to the berth, which lasted for about 2.5 hours, a constant rain was falling. This accelerat-

ed the cooling of the cargo and reduction of its volume, and hence the pressure inside the cargo tanks. Although the IGS alarm sounded at the time of the low pressure, the crew were otherwise engaged in the tie-up procedures, and did not appreciate the rate of the pressure drop.

Lessons learned

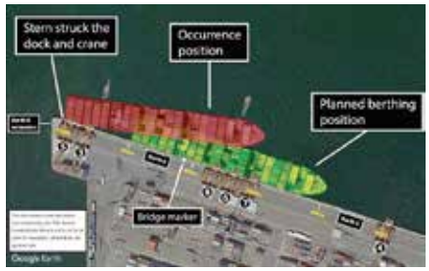
- On a vessel, you can sometimes be faced with conflicting priorities. By keeping your situational awareness, you will be in a better position to react accordingly.
- This incident shows the importance of investigating close calls of all kinds. Find out why something happened in order to introduce corrective action so it doesn't happen again.

Tug order mix-up: Mars 202112

As edited from TSB (Canada) report M19P0020

A container vessel was inbound to berth under pilotage in the early morning, in darkness and light winds. Two tugs were secured fore and aft on the port side well before arrival. As a memory aid, the pilot had the tugs positioned alphabetically along the vessel's port side, securing "F" tug forward and "H" tug aft. The pilot was conning the vessel from the starboard side of the bridge and was gradually reducing speed. The approach to the berth was as expected for a very large and wide vessel; nearly parallel to the dock at about 10 metres off with a speed of approximately 1.3 knots. There were no significant effects from the ebb tide. With approximately 200 metres to advance, the pilot ordered the engines dead slow astern in order to reduce speed to less than one knot.

In anticipation of the stern moving towards the berth due to the astern engine order, the pilot in error requested "F" tug (forward) to back up on the line and take up the strain. As tension came on the line, the vessel's stern started moving towards the berth. The pilot ordered "F" tug to increase power to maximum and "H" tug (aft) to push maximum. This error in tug orders resulted in the vessel's stern pivoting rapidly toward the berth, the exact opposite of the intended action.



The container vessel's stern hit the berth.

The master attempted to alert the pilot to what was going on. At the same time, the pilot ordered the bow thrusters full to starboard, the engines dead slow ahead, and the helm hard to starboard. However, with the tugs still operating at maximum power in the wrong direction, there could be no stopping the pivot. With the vessel now at an angle of about 10 degrees with the berth, the flared stern struck the quay and made contact with one of the shore cranes, which collapsed inwards toward the terminal, the boom falling onto the vessel.

Investigation findings

Although ultimately the allision was caused by human error, the investigation also found that there has been an increase in the size of container vessels berthing at the port over the last decade, and no corresponding upgrades to the terminal such as more appropriate fenders.

Lessons learned

- If effective bridge resource management (BRM) is not maintained by bridge teams, including pilots and tug masters, there is a risk that errors will go uncorrected and cause unwanted consequences.
- Some port infrastructure has not kept up with increases in vessel size and mariners should be aware of these inconsistencies.

Soot blowing causes deck fire: Mars 202113

A vessel had just left dry dock and was underway to another port for bunkering. In the late afternoon, a fire broke out on the poop deck in the area used for garbage collection. Within minutes, the fire party mustered and was able to extinguish the fire without further incident.

Investigation findings

The company investigation found that a quantity of combustible material, such as craft papers and plastic covers used to protect the ship's alleyways while in dry dock, had been left on deck and not secured in closed containers. A soot-blowing procedure was undertaken while underway, and it is probable that hot embers ignited the loose garbage.

Lessons learned

- Loose garbage is always a hazard, for fires, but also for safety and cleanliness.
- Certain activities, such as dry dock, can leave inordinate amounts of waste on board. Proper planning can alleviate this hazard.
- Soot blowing can introduce fire hazards on deck and company procedures should take this into account.

The shore crane's boom fell onto the vessel.

All Mars Reports are also published online, www.swzmaritime.nl.

VAN DE BESTUURSTAFEL

De afdelingen bieden via webinars over diverse technisch nautische onderwerpen sinds enige tijd een interessant programma aan de leden. In de meeste gevallen kunnen de videoregistraties van de presentaties op een later tijdstip op YouTube worden bekeken. Door de digitale mogelijkheden kunnen nu ook KNVTS-leden in de andere afdelingen kennis nemen van een presentatie die door een bepaalde afdeling is georganiseerd.

Gelet op de stand van vaccinaties, ziet het er helaas naar uit dat wij nog wel geruime tijd op deze wijze met elkaar contact zullen moeten onderhouden, zonder de mogelijkheid tot een persoonlijk gesprek en het drinken van een glas. De webinars worden via de gebruikelijke kanalen van tevoren aangekondigd en er wordt u aangeraden van de geboden mogelijkheden gebruik te maken door tijdige aanmelding.
De overheidsmaatregelen ten gevolge van de coronapandemie spelen ook de organisatie van het jaarlijkse Maritime Awards Gala (MAG) parten. Het is op het moment van schrijven niet bekend of het MAG dit jaar in november plaatsvindt en zo ja, in welke vorm. Mede omdat het MAG in november 2020 geen doorgang kon vinden, heeft de KNVTS besloten dat het wel gewenst is dat eind dit jaar de KNVTS Schip van het Jaar-prijs wordt uitgereikt. De inschrijvingen van 2020 en de inschrijvers van 2021 zullen eind dit jaar derhalve kunnen meedingen naar deze prijs, ongeacht of het MAG doorgang vindt. De inschrijving voor deze prijs staat vanaf 5 maart voor de werven open. De vakjury hoopt op veel inschrijvingen!
Voor wat betreft de tezamen met de Verolme Trust uit te reiken Maritime Students Awards geldt dat deze awards naar verwachting begin 2021 door de voorzitters van de KNVTS-afdelingen lokaal kunnen worden uitgereikt. Voor de award-winnende studenten en hun ouders kan in beperkte opzet binnen de afdelingen bij dit hoogtepunt worden stilgestaan.

UITNODIGING VOOR DE ALV 2021

De Algemene Ledenvergadering 2021 zal – afhankelijk van de dan geldende coronamaatregelen – op woensdag 19 mei 2021, worden gehouden bij de Koninklijke Roei- en Zeilvereeniging "De Maas" te Rotterdam of digitaal.

De benodigde documentatie wordt via de KNVTS-site (afgeschermde deel onder "Leden") bekendgemaakt en aan de leden waarvan een e-mailadres bekend is, toegezonden. Controleer uw mail en de KNVTS-site regelmatig!
Vanaf donderdag 18 maart zijn de eerste documenten op de KNVTS-site geplaatst, te beginnen met het voorstel leden van het Hoofdbestuur 2021-2022.

VOORSTEL LEDEN VAN HET HOOFDBESTUUR 2021-2022

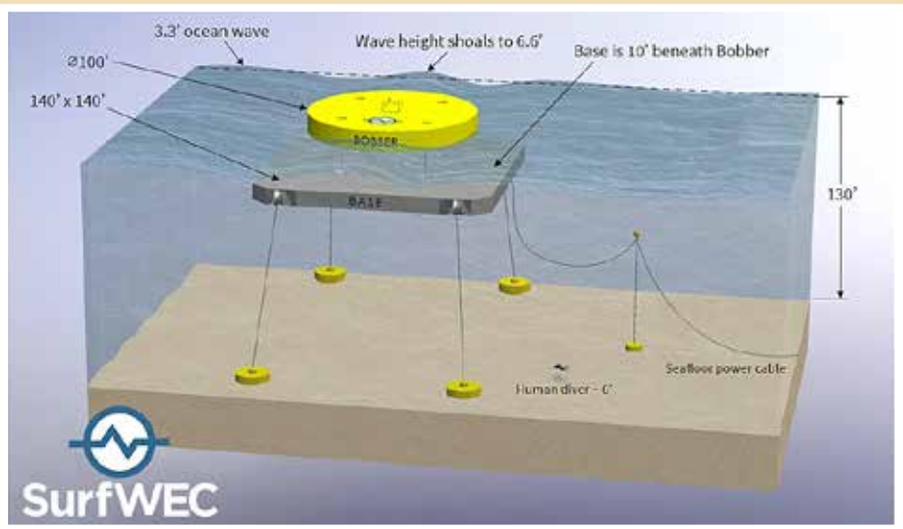
Op de Algemene Ledenvergadering (ALV) van 19 mei 2021, die – afhankelijk van de dan geldende coronamaatregelen – zal worden gehouden bij de Koninklijke Roei- en Zeilvereniging "De Maas" te Rotterdam of elektronisch (zie voor uiteindelijke keuze de KNVTS-website) zullen binnen het huidige Hoofdbestuur een aantal bestuursleden terugtreden.

Het Hoofdbestuur 2020-'21 bestaat uit:
- Arnold van Steenderen, voorzitter
- Joep Broekhuijsen, vert. afd. Zeeland
- Tjerk Feenstra, vert. afd. Noord/penningmeester
- Ton Bos, vert. afd. Amsterdam
- Wim Veldhuyzen, vert. afd. Rotterdam
- Marieke School-Brouwer, lid
- Mees van Wijngaarden, lid

De volgende hoofdbestuursleden treden bij de ALV terug vanwege het vervullen van twee achtereenvolgende perioden van drie jaar en zijn volgens de statuten niet direct herkiesbaar: de heren Broekhuijsen, Feenstra, Veldhuyzen en Van Wijngaarden.
Het Hoofdbestuur stelt voor het aantal hoofdbestuursleden voor het bestuursjaar 2021-'22 vast te stellen op zeven. Het nieuwe bestuur zal uit zijn midden een voorzitter, penningmeester en notulist kiezen.
Door de afdeling Zeeland wordt als afdelingsvertegenwoordiger voorgedragen de heer Peter Wehrmeijer. Door de afdeling Rotterdam wordt als afdelingsvertegenwoordiger voorgedragen de heer ing. Taco Terpstra. De afdeling Noord is er nog niet in geslaagd met een afdelingsvertegenwoordiger te komen. De afdeling Noord zal alles in het werk stellen om – rekening houdend met de noodzakelijk te volgen procedure – zo snel mogelijk met een kandidaat te komen. Zodra deze kandidaat bekend is, worden de leden hiervan in kennis gesteld.
Door tien KNVTS-leden gezamenlijk wordt voorgedragen de heer ing. Erik Klok MSc, MBA. Een uitgebreide beschrijving en motivatie van de voorgedragen bestuursleden is te vinden op de KNVTS-website.
Volgens artikel 13 van de Statuten van de KNVTS kunnen alle stemgerechtigde leden uit een niet bindende voordracht kandidaten aanmelden die door ten minste tien leden gezamenlijk zijn voorgedragen. Kandidaten kunnen tot 19 april 2021 schriftelijk worden aangemeld via info@knvts.nl of via algemeensecretaris@knvts.nl.
Ondanks verscheidene oproepen voor kandidaten voor het KNVTS-Hoofdbestuur onder andere in persoonlijke gesprekken zijn er geen andere leden geweest die zich hebben aangemeld.
Het Hoofdbestuur hoopt door bovenstaand voorstel te zorgen voor de noodzakelijke continuïteit en verjonging in het Hoofdbestuur. Het bestuur is van mening dat hiermee op een adequate wijze invulling kan worden gegeven aan de ambities en doelstellingen van de KNVTS en de veranderingen richting de toekomst.

LEZINGENPROGRAMMA APRIL

KNVTS afdeling Amsterdam
Wednesday April 21st, 19:30-20:30
Webinar: SurfWEC – The stone cold realities of Wave Energy Conversion
Speaker: Rik van Hemmen, President of Martin & Ottaway, Inc.
Wave Energy Conversion (WEC) is the third leg of readily available sustainable energy next to solar and wind. Solar and wind are now part of the economically competitive energy production package, but WEC has not yet jumped the chasm.
There have been numerous attempts at WEC over the last forty years or so, and while some systems are actually working, compared to wind and solar, there has been no progress in large scale investment in utility level WEC.
While there are numerous technical papers about the various WEC approaches, there is a disturbing dearth of papers about the economics of WEC. This appears to be a big dirty secret in WEC, because any economic analysis of present WEC approaches appears to indicate that WEC cannot be made to be economically viable. However, in 2012, Mike Raftery proposed an approach now called SurfWEC that appears to be able to break the economic logjam. This presentation will discuss the state of the art of WEC and explain why SurfWEC may be the technical approach that allows WEC to enter the sustainable energy triad.
More information: The webinar will be recorded. After the presentation, there will be a half hour for Q&A. This lecture will be given in English. Please register for the lecture through the link on our website, www.knvts.nl. There is no deadline for registration.



SurfWEC may be the technical approach that allows Wave Energy Conversion (WEC) to become be economically viable.

KNVTS afdelingen Noord, Rotterdam en Zeeland
Door de huidige omstandigheden worden er tot nader order geen fysieke bijeenkomsten georganiseerd. Wij verzoeken u de website en LinkedIn-pagina van de KNVTS te blijven volgen omtrent meldingen over webinars.

IN MEMORIAM

De heer Capt. T.T. Zondag is 7 februari 2021 op 63-jarige leeftijd overleden. Hij was het laatst woonachtig in Beilen en is als directeur werkzaam geweest bij Stichting NTTA in Groningen. Hij was ruim 8 jaar lid van de KNVTS.

De heer P.J.M. van den Boom is 1 maart 2021 op 93-jarige leeftijd overleden. Hij was het laatst woonachtig in Winschoten en is als manager BUS werkzaam geweest bij Keppel Verolme BV in Rozenburg. Hij was ruim 53 jaar lid van de KNVTS.

De heer ir. C.J. Verkleij is 5 maart 2021 op 93-jarige leeftijd overleden. Hij was het laatst woonachtig in Vlissingen en is als hoofdingenieur werkzaam geweest bij de Koninklijke Schelde Groep BV in Vlissingen. Hij was ruim 38 jaar lid van de KNVTS. In het aprilnummer van SWZ|Maritime wordt een uitgebreide in memoriam van de heer Verkleij opgenomen.

SWZ|Maritime is onder meer het periodiek van de Koninklijke Nederlandse Vereniging van Technici op Scheepvaartgebied, opgericht in 1898. SWZ|Maritime verschijnt elfmaal per jaar. Het lidmaatschap van de KNVTS bedraagt € 88,00 per jaar, voor juniorleden € 39,00 per jaar, beide inclusief dit periodiek. Een digitaal lidmaatschap (alleen voor studenten) kost € 15,00 per jaar. Het geeft u de vooraankondigingen van de maandelijkse lezingen, te houden op vier verschillende plaatsen in Nederland en korting op verschillende activiteiten. U kunt zich opgeven als lid bij de algemeen secretaris van de KNVTS, Zeemansstraat 13, 3016 CN Rotterdam, e-mail: secretariaat@knvts.nl of via het aanmeldingsformulier op de website: www.knvts.nl.

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SWZ is de eigenaar en uitgever van de titels Schip & Werf de Zee en SWZ|Maritime. Het bestuur van SWZ wordt gevormd door de participanten in SWZ (KNVTS en Stichting de Zee), die elk vier bestuursleden benoemen uit de doelgroepen van de lezers en bestaat uit de volgende personen:
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