CLEANSHIPPING INTERNATIONAL

SUMMER 2020

ROOM FOR MANOEUVRE
What will be the effect of covid-19 on decarbonisation in the industry?

A SILENT REVOLUTION
How wind power is changing the face of shipping

AIR APPARENT
Why air lubrication systems offer a way forward

The membership journal of CLEANSHIPPINGALLIANCE2020

PureteQ

THE SCRUBBER MAKER

We make scrubber systems for shipowners who want to save money by continuing use of HFO with scrubber while retaining a greener profile than those who use expensive compliant fuel. All scrubber systems come with state-of-the-art intuitive control systems with full remote accessibility. In times like these it is very convenient to get 24/7 remote on-line support/guidance to ship crews from our professional marine engineers. Our systems feature the lowest OPEX in the business and are easy to install. We guide the shipowner and other stakeholders through the process from order to sea-trial and approval. Once approved, PureteQ PureServ is able to quote a service agreement for any scrubber system for safeguarding MARPOL compliance as well as operational performance.

WWW.PURETEQ.COM

CLEANSHIPPING INTERNATIONAL

Editor: **Nick Savvides**
editor@cleanshippingalliance2020.org

Project Director: **Jonathon Ferris**
jonathon.ferris@cleanshippingalliance2020.org

Sub-editor: **Samantha Robinson**
sam.robinson.journalist@gmail.com

Publisher: **Bill Robinson**
production@cleanshippingalliance2020.org

Chief Executive: **Ian Adams**
ian.adams@cleanshippingalliance2020.org

Designer: **Justin Ives**
justindesign@live.co.uk

CLEANSHIPPINGALLIANCE2020.ORG

Knowledge grows

Quality
Reliability
Cost efficiency

The easy solution
Exhaust gas cleaning technology

www.yaramarine.com

by Nick Savvides, Editor, *Clean Shipping International*

IS TOURMALINE THE **GREEN SHIPPING SAVIOUR?**

In the maelstrom that has become the global economy, it is very easy to forget that the major environmental challenge faced by the maritime sector at the beginning of the year was the IMO2020 regulation that limits sulphur in fuel to 0.5%, globally.

Late last year and even in the first few weeks of this year, it looked like the sulphur cap would dominate the maritime news all year. Fast forward six weeks and the exercising of mental capacity has shifted decisively to coronavirus.

The sulphur conundrum has not disappeared, however, and those operating exhaust gas cleaning systems (EGCS) will be interested to hear about new developments, or rather the possibility of a new development.

Over the first part of the past decade, a Singapore engineering company designed a two-stage scrubbing process that first of all cleaned the SOx from the exhaust and in the second stage extracted NOx and carbon from the gases.

Ten years ago this was a godsend, a technology that was too good to be true. It allowed ship operators to fit one system and the vessel would meet the IMO2020 regulation that became enforceable in January this year, the Tier III Nox regulations, which were implemented on 1 January 2016 and much of the carbon curbs that have yet to be decided.

There had to be a catch. Well, yes and no. The catch was that the system used alkaline water, delivered through an expensive system of electrolysis. It appears, although it is by no means certain, that this put paid to what the Singapore company, Ecospec called CSNox.

However, UK-based engineer Robert Allen has perhaps revived the Singapore design by developing a cheaper method of producing alkaline water.

Clean technology is within the industry's grasp. The green lobby baying for new clean technology to be developed in the wake of the covid-19 crisis, the green new deal, could well get their wish. Allen has tested this system, which uses an electrically charged crystal called tourmaline, to produce high pH water at a cost of less than US$10/m^3.

Allen's small-scale tests were a success. Now, he says it is time for the investment in the design to develop a large-scale system that can prove the EGCS can be scaled up and will be cost efficient, clean and will meet the needs of a modern environmentally conscious society.

That requires an investor with vision to see the bigger picture to pair with an owner that has a similar visionary guile to allow his or her vessels to be the testing grounds for the new systems, and the engineers with the technological acumen to make the system work.

Tourmaline is not a new substance, in that patents dating back to the early 1990's were lodged, with the knowledge that the crystal could produce alkaline water with a number of applications for the substance.

Most recently tourmaline, which is crushed and then surrounded by ceramic to create pellets of around 3-5mm, is used to clean tap water and is being advertised in mainstream publications.

Allen believes this is a unique opportunity for the industry to develop a technology that is low cost, efficient and can help the maritime sector to meet its global carbon reduction commitments with existing vessels.

You can read more about this remarkable system on page 18.

Don't just comply – be a step ahead

Alfa Laval PureSOx continues to lead the way

You won't be alone in choosing a SOx scrubber. But you will be a step ahead, if you select the scrubber at the forefront: Alfa Laval PureSOx. At sea since 2009, PureSOx has the record others aspire to, with every system ever sold in operation and in compliance.

Built on 100 years of marine experience, PureSOx has been chosen for hundreds of vessels to date. But what matters more are the returning customers, convinced by smooth installations, proven results and first-rate global service. They know PureSOx will keep them ahead – now and in the future.

Start getting ahead at www.alfalaval.com/puresox

www.alfalaval.com

CLEANSHIPPING INTERNATIONAL

» p10

» p24

» p26

» p51

Measuring emissions at sea

We are on your wavelength

Simplicity is the key for stack emission measurements at sea and the GAA610-M marine emission monitoring system carries all necessary type approvals. The internal gas-filled cuvettes simplify calibration and remove the need to hold gas cylinders onboard. Dynamic QR codes generated on the analyzer display allow easy transmission of all relevant diagnostic information and ABB Ability™ Remote Assistance provides secure remote connectivity to our global team of experts. Measurement made easy. **to.abb/NOv4ndPn**

VIRTUAL REALITY

by Ian Adams
Executive Director,
the Clean Shipping
Alliance 2020

"Posidonia and the like are more than about meetings — they are networking events where people get to know each other. That is not something that can be done via a webcam"

In the previous issue of *Clean Shipping International*, I described our plans for the year ahead, which included the first meeting of the Technical Committee to be held in either Naples or Amsterdam in April. As we all know now, things changed very rapidly in March with the onset of the covid-19 pandemic.

As I write this column, the UK is taking its first tentative steps out of lockdown and by the time you read it, we will hopefully be further in the process of lifting lockdown and our world starting to resemble what it was before. However, it is difficult to predict what aspects of our lives have changed for ever.

It was clearly not possible for us to hold our planned Technical Committee meeting. However, having tried out a few webinar platforms and taken part in several commercial webinars, it was agreed that we would run the Committee as a "virtual" event. And so, on 28 May at 13.00 British Summer Time, the first meeting of the Technical Committee convened. There were attendees from Singapore, Europe and North America spanning a 12-hour time difference. In total, at its peak the attendance reached 35.

Two presentations, one from Star Bulk Carriers Corporation and one from Grimaldi Group, started proceedings. This was followed by a question and answer session, which then became a general discussion. At the end, all agreed that the meeting had been a positive experience and plans are now being prepared for the next one. We will continue to hold these meetings until such time as a physical version is possible. We are also seeking volunteers to present case studies to the membership — anyone interested in doing so should contact the Secretariat.

In the meantime, for those of you who missed the webinar, it is available to view in the members area of our website.

The International Maritime Organization (IMO) has postponed all meetings up to the end of July. IMO has stated that when the meetings resume, the priority will be to hold Council meetings followed by the Marine Environment Protection Committee and Maritime Safety Committee. We await further updates from IMO as to when the meeting programme will restart, but given the size of the meetings this may be some time as it is following the health advice of the World Health Organization and the UK government.

Going forward, what can we expect in the post-covid-19 world? There has been much speculation about the "new normal". Many employers have found that a workforce working from home is working well. The use of technology such as Zoom, Microsoft Teams and other software has enabled meetings to be held and projects to be progressed.

The issue for the maritime world, however, may not be quite that simple. Take as an example Posidonia, which was due to be held in early June. That would not work in a virtual world. Posidonia and other exhibitions such as SMM and Nor Shipping are more than about meetings — they are networking events where people meet and get to know each other. That is not something that can be done via a webcam.

In the meantime, I hope that you enjoy this edition of CSI and that you, your families and colleagues stay safe.

For more information,visit: cleanshippingalliance2020.org

ABB: WE ARE ON YOUR WAVELENGTH

BUSY PORTS AND CLEAN AIR

Some of the world's most beautiful cities are blessed with an ocean setting or sit on the banks of a navigable river — places such as Barcelona, Brisbane, Liverpool, London, Shanghai and Sydney might spring to mind.

Through history, these cities have grown as centres of trade due to their maritime connections. In some of these locations, shipping has moved out of the city centre to deep water ports close by. However, many densely populated cities such as Rotterdam and Singapore are still very active trade and passenger ports.

From a public health perspective, port cities have been some of the biggest winners since the implementation of the IMO 2020 marine emissions standards. Populations located close to busy shipping lanes, such as the Straits of Malacca between Indonesia and Malaysia, and the English Channel between Dover and Calais, will also feel the benefit of improved air quality resulting from cleaner exhaust gas emissions.

ROBUST MONITORING

As from the 1 January this year, the low sulphur emission levels in the IMO regulations became effective worldwide. The measurement of nitric oxide emissions is also required. This brings maritime air pollution control closely in line with shore-based power plants, cement works and oil refineries, where continuous emissions monitoring systems (CEMS) have been used for decades.

The selection of instrumentation for ocean-based emission monitoring can draw from lessons learned in land-based CEMS applications. ABB has decades of experience in emissions monitoring on land and at sea. Its

marine CEMS product manager, Carolin Seubert, says that "simplicity is the key for CEMS at sea. On the oceans, gas analysers inevitably get the roughest possible treatment. Cruise ships on the Caribbean, for example, confront 10m waves during the hurricane season — that's just the way it is out there.

"Knowing that, we incorporated a robust non-dispersive ultra-violet (UV) Limas analyser into our GAA610-M marine emission monitoring system. It uses light in the UV wavelength to analyse NOx concentrations. For the sulphur dioxide and carbon dioxide measurements, we rely on another low-maintenance technology using light in the infrared (IR) wavelength. This is based on our renowned Uras26 non-dispersive IR gas analyser." Both techniques require minimal operator intervention.

LOW MAINTENANCE

"Sample preparation of the exhaust gases coming to the GAA610-M is optimised to cope with typical maritime liquid fuels" Seubert adds. "The oily carry-over of unburned hydrocarbons from the engine means that hot-wet analysis systems will quickly get fouled. So we use a cold-dry sample handling system to avoid this problem."

Calibration of the CEMS instrumentation is a fundamental requirement for emission monitoring compliance. An analyser that is not correctly calibrated cannot be relied upon to report the required precise environmental emissions data.

The CEMS analysers are designed with busy maritime engineers in mind. The UV and IR gas analysers in the ABB GAA610-M are fitted with cells filled with gas mixtures of a known concentration that enable automated calibration of the gas analyser. "It's ideal for shipping operators because they do not need to take gas mixture cylinders on board to calibrate their CEMS gas analysers," says Seubert.

GEARING UP FOR GROWTH

The combination of a surge in demand for marine exhaust gas cleaning systems and the growth in emission monitoring requirements is driving a peak in the demand for marine CEMS gas analysers. Seubert says. "We're ready. Having the best products is not enough — we also need to have the best production."

To ensure sustainable worldwide availability of the GAA610-M, ABB has recently replicated the manufacturing capability that it has in China to its facility in Frankfurt.

Type approval certification is also highly sought after in this sector. In recognition of that, both factories will produce equipment certified to DNV GL, Lloyds Register, ABS, Bureau Veritas, NK and CCS. Hundreds of ships are using ABB marine CEMS systems today and ABB has confirmed that hundreds more will be installing their gas analysers this year. Demand and quality expectations are high — and the production capacity is in place to meet the demands.

DIGITALLY ENABLED

Dynamic QR codes are integrated into the ABB GAA610-M marine CEMS system display panel. The idea is to help operators get closer to 100% uptime availability for their gas analysis instrumentation. The dynamic QR code displays the latest system configuration data and the real-time analyser status. The QR code can be scanned using a smartphone and communicates with a proprietary ABB App called "my Installed Base (myIB)". The maritime instrumentation technician can send real-time information to an ABB service expert to get immediate guidance on the most appropriate maintenance activity.

Data privacy and data security are key topics in this digital age. The dynamic QR code technology is sensitive to this issue because there is no permanent data transfer from a shipping operator's gas analyser to our systems.

PARTS AND PEOPLE IN EVERY PORT

There's no denying it — despite all the advances in digital technology, sometimes a phone call is simply not enough. Hands-on maintenance is occasionally required to return the system to tip-top condition. That's where ABB's team of 600 certified service technicians worldwide is unparalleled. Whether the ship is in port at Barcelona or Bangkok, the right spare parts and a competent expert will be on hand to execute a maintenance procedure.

On the topic of services, Seubert confirms that "the trends for services applied to gas analysis instrumentation are to offer more, to integrate them more closely with digital solutions and to offer more flexibility about how the services are consumed."

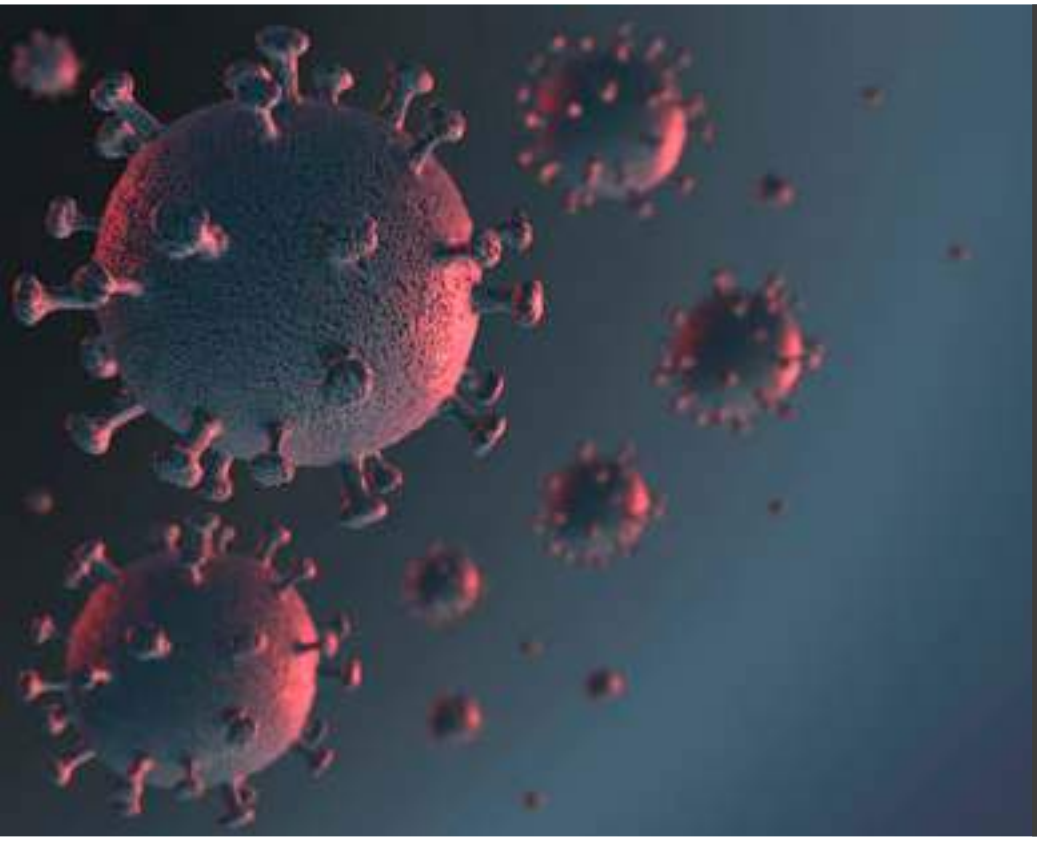
ABB Measurement Care service packages are a modular framework that allows each operator to customise a service package that meets their needs. The services extend through the full lifecycle of gas analysis instrumentation. They begin with product selection proposals, equipment installation, commissioning and training. In the operational phase the focus shifts to spare parts, consumables, maintenance, technical support and repairs. As time moves on, extensions, upgrades and retrofits are the order of the day. And, when twilight finally comes, it's time to consider replacement and end-of-life services.

AT ABB, ALL GOOD THINGS COME IN THREES

Seubert sums up the ABB Measurement and Analytics business line's overall approach as: "working in the sweet spot. That means combining three ingredients to bake the perfect cake: the right hardware, the best services and leading digital innovations. The right gas analyser can make a big difference. The kit inside the box really matters. Standing still is no option — our products and services are continuously evolving to ensure that our gas analysers are ideally suited to the application."

Instrument operators sometimes require support for their gas analysers. "That's where we exploit the latest digital innovations to link our expertise to the end-users on the ocean," Seubert continues. "We're on a mission to control our customer's costs, cut complexity and make their CAPEX go further. That's why we work tirelessly to continuously improve our marine emission monitoring systems and the services that are built around them".

For more information please contact:
Stephen Gibbons
Email: stephen.gibbons@de.abb.com
ABB Automation GmbH
Stierstaedter Str, 5
60488 Frankfurt am Main
Germany
Website: abb/NOv4ndPn



What will be the effect of covid-19 on the decarbonisation of shipping? The following examines both the short- and long-term effects — and the reasons for both optimisim and pessimism

COVID 19 AND DECARBONISATION

Dr Tristan Smith, Reader in Energy and Shipping, University College London Energy Institute

When first asked to write this, we were still in the early stages of the crisis (at least in Europe) with early signs emerging on how covid-19 might impede or accelerate our response to the risk of dangerous climate change The impacts of covid-19 on my own work have meant a delay to writing this and, in the interim period, thousands of words have been written, including on the interaction between covid-19, shipping, decarbonisation more generally, and shipping's decarbonisation. The two basic forces at play being characterised as:

» **Pessimism** — doubt that governments and firms will have the spending power coming out of covid-19 in order to make the investments needed to decarbonise as needed
» **Optimism** — that covid-19 acts as a wake-up, a cruel metaphor tipping us (society, governments and firms) into realisation of the more general urgency for sustainability

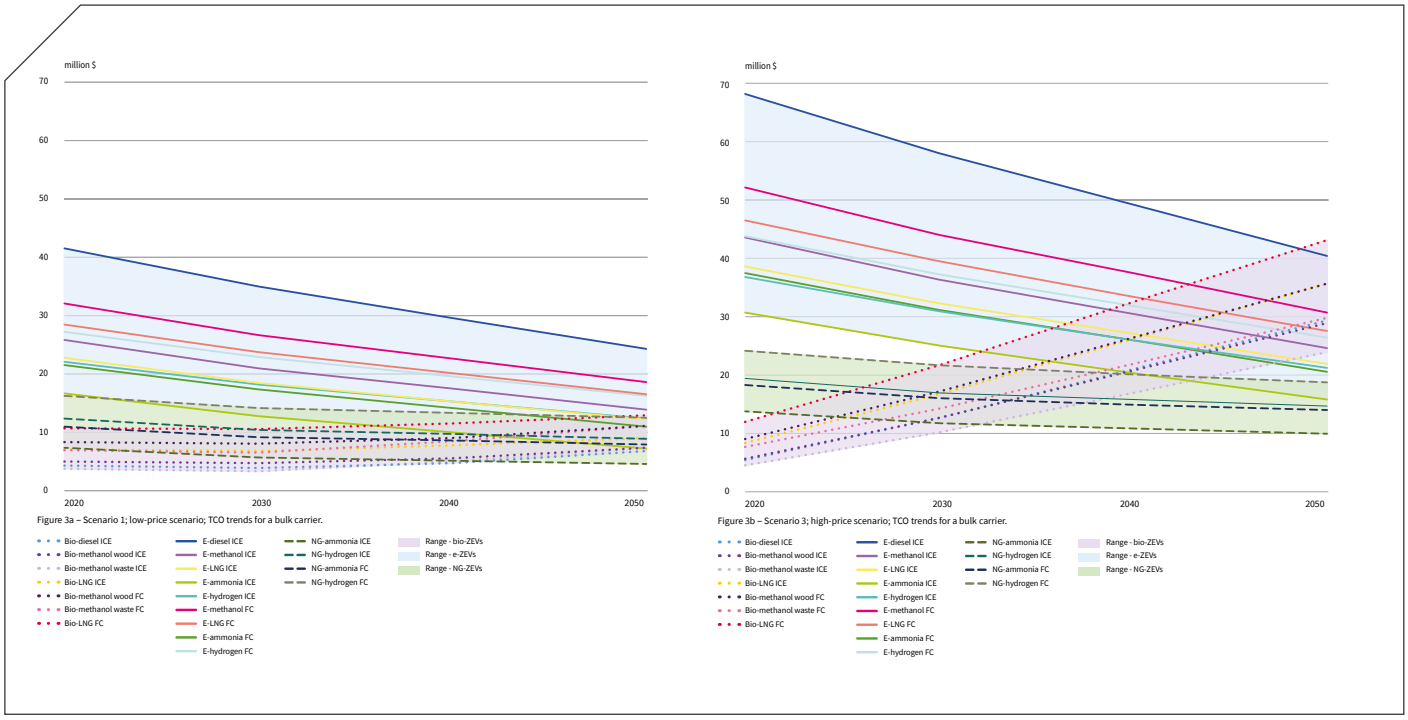
With these two counteracting forces at play it is hard to identify what the net impact might be (including on a subsector such as shipping). However, to attempt to do so, this article considers the covid-19 crisis' impact on shipping's decarbonisation primarily based on how business case and regulation might be disrupted.

This is broken down both into the short term (to 2025) and the longer term (2025+). The specifics of investment allocation (by firms and governments) are not second guessed, but discussed in light of the analysis, in a set of concluding remarks.

SHORT RUN (THE EARLY 2020'S)

A harder business case for lower carbon intensity and the early shift away from fossil fuels.

Candidate non-fossil fuels (bio and hydrogen-derived fuels) already looked likely to be more expensive than the LSFO and MDO predominantly used today, at least in the short-term. This makes sense, otherwise they would be in use already. Covid-19 is clearly a major contributor to the



Total Cost of Ownership for a bulk carrier.

recent global contraction in demand for oil and the crash in oil price, which has in turn made low sulphur fuel oil (LSFO) and marine diesel oil (MDO) dramatically cheaper than they were at the start of the year.

Candidate non fossil fuels are incredibly hard to forecast prices on, but the new entrant biofuels were becoming more competitive and approaching some of the upper bounds in MDO price movements, especially those transiently high oil prices shipping experienced during Q4 2019 and Q1 2020 around the introduction of the 0.5% sulphur limit.

With prices for those biofuels significantly influenced by costs of production, there is less of a driver for a reduction in their price than the drivers to lower fossil oil prices. The over-supply induced oil price crash has made the price spread to biofuels larger and so the business case to switch in the short run away from fossil appears to have become harder.

For some with pockets deep enough to take a long-run strategy, or who have found niche regulatory or other commercial incentive to override a pure energy-price related business case, this change in price spread may not be enough to change their decisions. But for those where the decision was already marginal, it will not help.

> *"Policymakers know fuel price alone is not sufficient to manage shipping's decarbonisation"*

Besides the use of non-fossil fuels, there are other means to reduce carbon intensity including investment in energy efficiency technologies and modifications to operational practices most notably ship speeds and voyage optimisation.

Much of the change here is also driven by the business case and not regulation. And lower oil prices mean a longer return on investment for technology (given payback for the investment comes from fuel savings, which are fuel price driven), and it can also mean higher ship speeds and voyages less optimised to lower fuel consumption.

The most obvious illustration of the latter is the return by some (for example CMA CGM among others) of sailing "the long way round" Africa to avoid Suez and the canal charges, at the expense of much higher fuel consumption. Clearly, ship operators are not incentivised by minimisation of fuel costs alone.

Policymakers know fuel price alone is not sufficient to manage shipping's decarbonisation, which is why an expected driver for lower carbon intensity during this coming decade, particularly in the existing fleet, is regulation by IMO known as "short-term measures".

Two main categories of policy options are under consideration: those improving either the design/technical carbon intensity of shipping, and those improving the operational carbon intensity of shipping. A decision could

continued on page 14 >

ALFA LAVAL: AT THE FOREFRONT WITH PURESOX SCRUBBER SYSTEMS

Following years of preparation, the global sulphur cap became reality on 1 January 2020. While most of the marine industry recalibrates its fuel use, customers with Alfa Laval PureSOx systems on board are a step ahead. Not only can they continue sailing with economical heavy fuel oil, they can feel confident about their scrubber solution and its future.

More than 10 years ago, the DFDS Ficaria Seaways entered dry dock for an expansion of its cargo space. While the vessel was being rebuilt, a hybrid PureSOx system — able to perform closed-loop as well as open-loop scrubbing — was retrofitted to clean the exhaust gas from its 21MW main engine. At the time of the pilot installation, the prospects for SOx scrubbers were anything but certain.

"Back in 2009, there were many who questioned the potential of SOx scrubbers," says Steven Pieters, Sales Director, Exhaust Gas Cleaning at Alfa Laval. "Not everyone was convinced that a scrubber could meet emission limits while operating in a marine environment and there were even deeper doubts about the water cleaning needed for closed-loop scrubbing."

CONFIDENCE BUILT ON PROOF

Today, the merits of PureSOx are undeniable, as are those of Alfa Laval's centrifugal water cleaning system. The PureSOx system on Ficaria Seaways has spent thousands of hours in compliant operation — and is still going strong. In fact, so is every other PureSOx system ever installed.

This flawless track record is underpinned by Alfa Laval's more than 100 years of experience as a marine supplier. Having developed a well-functioning PureSOx production apparatus early on, Alfa Laval has had the resources and ability to scale up manufacturing with retained quality. In combination with the technology itself, this has kept returning customers secure.

"The customers who invested in PureSOx before the global sulphur cap were ahead of the curve and today they're able to take advantage of that fact," Pieters says. "Our many references have shown time and time again that the technology and its benefits are sound."

SMART SOLUTIONS FOR SMOOTH INSTALLATION

As Pieters indicates, PureSOx has been installed on vessels of nearly every type and size. In the years since 2009, Alfa Laval has successfully completed hundreds of installations, carried out at all major shipyards worldwide. This has created unique insights that are constantly being applied to improve Alfa Laval's installation processes.

"We've found that delivering PureSOx scrubbers as prefabricated components and modules is a winning strategy, as it saves time and work on board," says Pieters. "For faster installation, the scrubber can also be built into a new funnel on the shipyard quay and then simply lifted on board."

Whatever the individual solution, planning and preparation are important. "Each installation has its own challenges," says Pieters. "To minimise the vessel's downtime, we usually perform some of the preparations while sailing."

STRONG CO-OPERATION IS ESSENTIAL

A vital aspect of reducing downtime, overcoming obstacles and ensuring success, Pieters emphasises, is ensuring tight co-operation between supplier, shipowner, shipyard and any engineering company involved. This is a matter not only

of strong documentation, but also of communication and routines.

"We appoint a dedicated project manager who takes responsibility for each retrofit," Pieters says. "It's important for that person to stay on top of current status and conditions, which is why we emphasise having local project managers who are readily accessible and in easy reach of the yard. Each new project begins with a kick-off phase, where our dedicated project team aligns the goals with the customer. Throughout the project, we have regular status meetings to deal with anything that arises and ensure that everything is moving forward."

By combining such practical measures with smart technical solutions, the total retrofit downtime can generally be limited to 2–4 weeks. "PureSOx customers today are a step ahead from the beginning, because we've learned from every installation performed," Pieters says.

WITH CUSTOMERS INTO THE FUTURE

Following installation, Alfa Laval takes responsibility for seeing that PureSOx is compliant, both through commissioning at sea and by facilitating the class and flag state approvals.

Just as importantly, the company takes long-term responsibility, helping customers to remain compliant throughout the system lifetime.

Alfa Laval's global service organisation, which offers 24/7 support and access to marine service engineers worldwide, has a comprehensive portfolio of defined PureSOx services. Ranging from sensor exchange to Performance Audits and connectivity, they aim to bring PureSOx customers predictably low costs as well as peace of mind.

"Our services for PureSOx are far-reaching and continue to expand," says Pieters. "Whether physically or digitally, we're committed to keeping PureSOx customers ahead for as long as they operate their systems."

For more information, visit: alfalaval.com/puresox

have been made to agree to implement one of these at MEPC 75 originally scheduled before Easter. However, that meeting's postponement (remaining, for now, unscheduled), does not work in favour of compensating for weaker business case drivers on lower carbon intensity.

LONG RUN

Covid-19 creates little change of the urgent need to decarbonise and could amplify the justification for policy to shift from fossil fuels, as well as improve the business case for blue hydrogen/ammonia.

For some time, our analysis work has shown that to get anywhere close to the IMO Initial Strategy GHG Reduction scenarios, shipping will need a rapid transition away from the use of fossil fuels. The mostly market driven reductions in carbon intensity using energy efficiency need to be built on over this decade, but from the late 20's onwards, a more radical shift for the sector and its energy suppliers appears impossible to escape.

The most recent study we have done on the subject can be found in analysis to support the UK government's Clean Maritime Plan. The energy mix that results from one of the less ambitious scenarios, albeit a scenario that is in line with the IMO strategy, illustrates the scale and speed of change to the conventional fossil fuel supply.

In much of our recent work on modelling the techno-economics of candidate future shipping fuels, the largest driver of the total additional cost to operation with those fuels is the fuel price premium of the fuel relative to the incumbent fossil fuels. Our most recent update to that area of analysis concluded yes, there are other impacts on the total cost (for many options: the capital cost of the extra storage and fuel handling equipment, the machinery, the loss of cargo carrying capacity due to a relative decrease in energy density of the fuel), but it is the price of fuel that is by far the most dominant driver in the relative competitiveness of different candidate future fuels.

Note that none of these plots have a comparator to a conventional marine fossil fuel (for example LSFO or MDO). So while cheaper oil and gas may mean an increase in the spread to non-fossil fuels, it does not remove the fact we need them to avoid dangerous climate change.

Policy was already needed to help close the gap to enable the business case for non-fossil fuel use and a lower oil/gas price environment will only make that necessity greater and provide a clearer justification.

There are even suggestions that lower fossil energy prices can make it easier to introduce GHG policy, because the lower price provides some headroom for a policy intervention to occur with no net increase in overall cost.

One inference from the plots is that before the oil/gas price reductions associated with covid-19, the lowest cost future fuel with good long-run potential was hydrogen/ammonia (initially from natural gas and CCS, blue, with potential to move to electrolysis production, green, in the future).

One consequence of the oil/gas price reductions will be a reduction in the price of blue hydrogen/ammonia and a likely improvement in its competitiveness relative to both green and biofuels.

This may provide a clearer signal and investment case for the use of blue hydrogen derived fuels (for example blue ammonia) in the transition from fossil fuel use and advance their deployment.

One of the uncertainties in shipping's decarbonisation is the role of the marine fuel option LNG. This cleaner fossil fuel has small and uncertain GHG advantages relative to oil-derived fuels. So the fossil variant cannot be a significant fuel in the decarbonised long run.

As shown in the graphs, LNG's bio and synthetic equivalents (liquid bio-methane and synthetic methane) are not competitive relative to hydrogen/ammonia in the long run, so also do not present a credible longer-term option.

However, as long as strong policy to shift shipping from fossil fuels is not present, there can be a business case for LNG relative to incumbent oil-derived fuels, as long as the expected price/availability of LNG bunkers relative to oil derived fuels offsets the higher capital cost of the equipment.

Under covid-19, the driver for LNG remains the short-term business case and whether that can create a return before policy drives a transition away from fossil fuels. While gas prices may now have a period where they are lower than they were in many forecasts produced last year, as long as similar price reductions are experienced by oil derived fuels, the spread and therefore the business case may not become stronger, or be significant.

Some firms may find a niche where investment in LNG as a marine fuel can work under these circumstances, but the risks created by the long run and of an acceleration away from fossil fuel continue to make a significant shift towards LNG directly as a fuel (as opposed to as a feedstock for blue hydrogen/ammonia) hard to foresee.

We know there is more oil and gas in current reserves than there is a market for (assuming we get anywhere close to achieving the Paris Agreement temperature goals). There appears little recognition in the energy sector (the oil-producing governments and corporates, the advisors, even the International Energy Agency) of a narrative about production and supply contraction of oil and gas anywhere close to a Paris Agreement compatible trajectory. But we also know there are 60+ governments writing or considering writing "zero GHG by 2050" into their policy and industrial strategies.

With dangerous climate change already locked in (the option is now to avoid catastrophic climate change), we can expect only growing disasters and therefore a crescendo of pressure for more governments to join this ambition or even increase it. This is creating a strengthening demand signal, removing demand from fossil fuels and increasing demand for its sustainable alternatives (renewable electricity, hydrogen and its derivatives).

This dichotomy (simultaneous pressure to sustain/increase supply and reduce demand for fossil fuels) embeds systemic risk of sustained over supply, as many governments come in to control demand for oil and gas in their economies in order

to fulfil domestic Paris Agreement commitments (Nationally Determined Contributions). In many ways, covid-19 may have brought forwards the long-run trend of lower/falling fossil fuel prices that was already the likely backdrop to shipping's decarbonisation.

Alongside the fossil fuel supply/demand dynamics, there is now a growing call for a non-fossil fuel supply stimulus being brought forwards and many governments rapidly forming hydrogen strategies. Covid-19 and the stimulus that will be needed to recover our economies has created the potential to bring forward actions that might have been scheduled for a few years into the future. This is partly because covid-19's disruption to our lives has made accelerated policy against cars and aviation and pro cycling and electrification easier.

It is also because the consequence of bailouts and much higher reliance on public funding across the private sector will make it easier for governments to influence and control the private sector in line with their climate commitments. As one government employee I spoke to recently elegantly expressed in metaphor: "We've been using screwdrivers up till now, Now we'll need to start using hammers."

There are also opportunities for firms arising. Oil and gas majors already had a toxic mix of increasing shareholder pressure to decarbonise, expectations of lower volume growth, strong potential for lower prices and for asset write-downs. With Shell and maybe others announcing dividend payment cuts, they will lose investors searching for a short-run profit and high dividend — one of their main drags on making longer term energy transition-orientated investments.

"Covid-19 and the stimulus that will be needed to recover our economies has created the potential to bring forward actions that might have been scheduled for a few years into the future"

If this can be aligned with government pressures, it could prove to be a pivotal point for this set of firms capable of providing at scale investment (and investment deployment) in technologies and infrastructure needed for shipping's decarbonisation.

Counteracting the opportunities that covid-19 has presented are the economic impacts of covid-19 on balance sheets. Governments and companies alike will face huge pressure to rein in spending and bring in revenue in the short term.

To conclude, the initial framing of a reason to be optimistic and pessimistic regarding the speed at which decarbonisation may move remains. However, the clarity and urgency of the challenge and the scope to take some control of it has never been greater.

PURETEQ: TAKING A DIGITAL APPROACH

The world is still grappling with the implications of Covid-19, coupled with both a financial and an oil crisis. Severe restrictions are being put in place by governments across the world to curb the pandemic. PureteQ's CEO, Anders Skibdal, believes: "The restrictions of travelling across borders or even within the same country may last for quite a while yet. In our opinion, it will take a long time before the world has recovered from the pandemic and the turmoil it is creating. In many ways, it will be a different reality, as we learn and adapt to the new situation. One small benefit gained during the crisis is that digitalisation within the shipping industry has really taken off — and it won't stop here."

PureteQ has been quick off the mark when it comes to embracing digitalisation on its scrubber systems. When developing its main control system, PureteQ began by using industrial software, but soon discovered that there were too many limitations and it ended up using standard windows software. This enabled PureteQ to develop a scrubber system that was smaller and more energy efficient than other systems on the market at that time. Using top-end components and innovative software, it increased the speed at which the cleaning capacity of the scrubber system adapts to actual loads.

Several larger scrubber suppliers were discussing what protocols to use, but PureteQ decided to maintain an open protocol to ease integration with other digital systems on board — after all, the data belongs to the shipowner and not the maker. Furthermore, it needed to ensure data was easy and safe to access from remote locations in case it was not possible to attend the vessel physically.

Another issue was the frequency of data collection. Most suppliers at that time took the legislation approach, but PureteQ decided to increase the logging of data, so that it could be used to analyse behaviour in detail and correct any errors — not just errors pertaining to the scrubber system and the parts that PureteQ delivers, but the entire integration of the systems. This would allow PureteQ's engineers to assist crews in troubleshooting and replacing parts, as well as predict the need for maintenance activity, thus reducing operating expenditure on the system.

Today, PureteQ service engineers support ship crews right across the world remotely, assisting with tasks such as flag state reporting, maintenance, replacement of parts, analysis and troubleshooting. PureteQ has proved the reliability and safety of conducting remote support to its clients.

PureteQ has engineers remotely helping clients across the globe

REMOTE ACCESS

Due to current travel restrictions, sea trials of newly retrofitted scrubber systems have been accomplished with only crew and surveyor on board. PureteQ marine engineers have been granted remote access, however, to analyse real-time data from the scrubber control system, advise crew and change settings as appropriate.

As the number of ships sailing with PureteQ scrubbers rapidly increases, so too is the number of marine engineers in PureServ, PureteQ's service department. To safeguard MARPOL compliance as well as the reliability of systems performance, PureteQ conducts remote surveillance of scrubber systems for many shipowners.

The frequency varies from logging on once a month to weekly checks of system performance and real-time compliance data. In some instances, remote engineers assist in flag state reporting and reporting to US Coast Guard. Soon, these features will be integrated in the control systems to ease the work for the crew.

Recently, PureteQ engineers had a case where the ship manager changed crew and did not have time to train the new crew or arrange a handover. Furthermore, the ship did not have time to take on compliant fuel. Shortly after departure, the ship experienced a shutdown of the scrubber system due to an error in the ship's management system, rendering the ship out of compliance. The Master called PureteQ's 24/7 service desk, which quickly located the error and performed on-line training in maintenance and operation of the scrubber system, so that the ship could continue its journey.

FULL SUPPORT

Another area in which the digital monitoring has been invaluable is with identifying faulty components. Like everyone else in the business, PureteQ has been faced with instances of substandard components and installation quality from otherwise reputable suppliers, but thanks to the digitalisation of systems, these faulty components have quickly been located and new replacement components sent out.

PureteQ's vision is clear: it will continue to go that extra mile for its clients. "Now and in the future, PureteQ as an EGCS manufacturer has the responsibility to support our clients to the best of our abilities and under any given situation," says Skibdal. "These days, it is very difficult to respond with service engineers and provide on-site support.

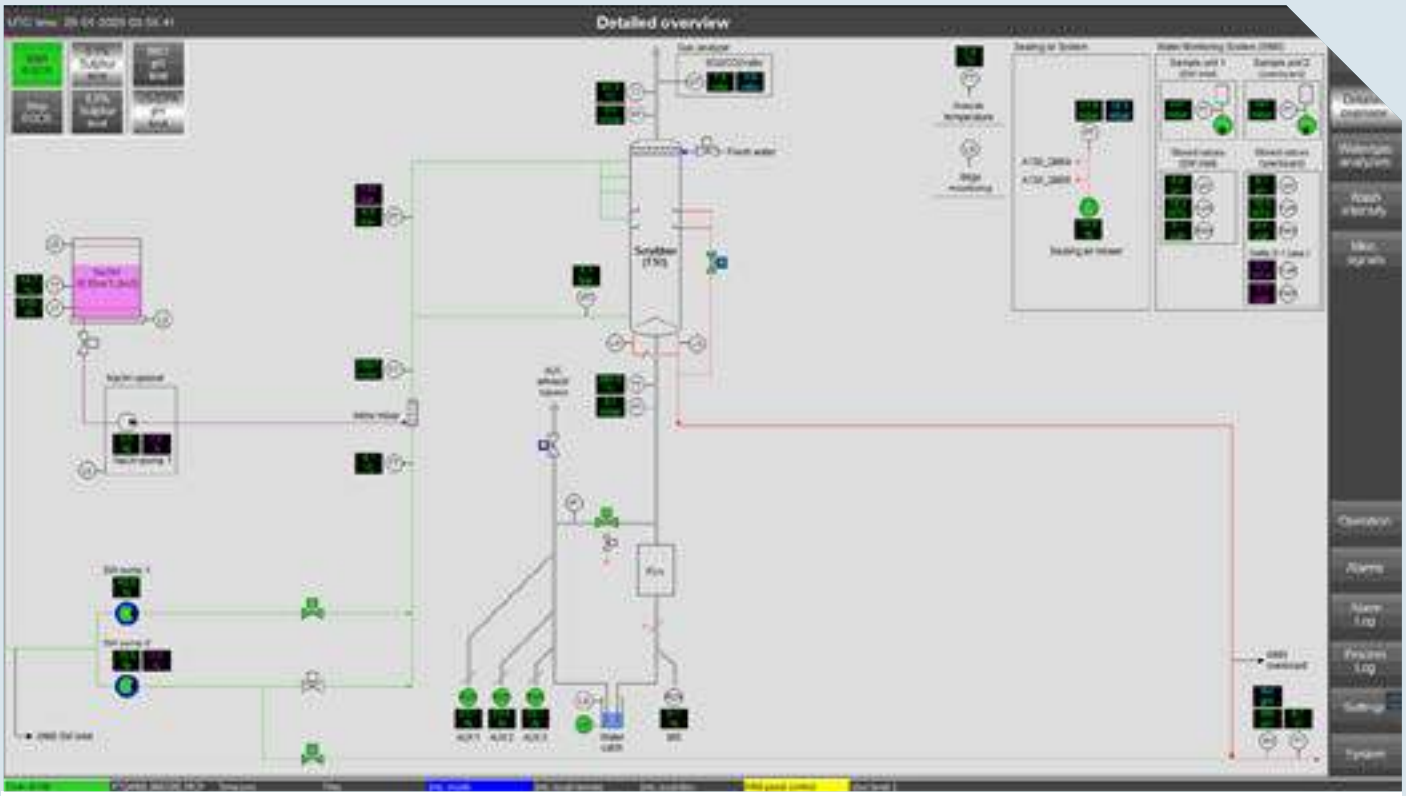
"However, it is our duty to provide full support to every client when requested. We have learned the value of making good use of digitalisation for our clients, who require safe, reliable and fast support at a fair price. After all, it is much cheaper — and safer in the current environment — to give remote support to ship crews than dispatch service engineers to the ship."

For more information, contact:
Anders Skibdal, CEO
Tel: + 45 4017 1400
Email: anders@pureteq.com

Michael Mouritzen, Sales Director
Tel: +41 4014 4481
Email: mim@pureteq.com

Allan Graff, Sales Director, Europe
Tel: + 45 4014 4439
Email: alg@pureteq.com

pureteq.com



Support includes pinpointing faulty components

Is tourmaline the answer when it comes to cleaning up a vessel's emissions? Engineer Robert Allen is on a mission to prove it's the way forward...

CRYSTAL CLEAR

In 2009, tests on the aframax tanker *Coral Sea* showed that Singapore company Ecospec Global Technology (EGT) had produced an exhaust gas cleaning system (EGCS) that would remove up to 100% of all sulphur oxides from the vessel's emissions, as well as substantial amounts of NOx and carbon dioxide.

UK-based engineer and fellow of the Institute of Marine Engineering, Science and Technology (IMAREST) Robert Allen gave a presentation at the CSA 2020 conference in London during February that suggested that EGT was on to something with its system — even if, ultimately, the company has apparently failed to achieve the sales it had expected and the system did not appear to match the performances that EGT's marketing department claimed for it.

According to EGT, it had produced the world's first commercially viable three-in-one emission abatement system. In its marketing for the system, EGT said: "It does not just achieve impressive removal rates for sulphur dioxide (SO_2) and nitrogen oxides (NOx), the CSNOx is also a revolutionary system that removes carbon dioxide (CO_2) all in one process, in a single system."

Branded the CSNOx system, the company claimed that emission abatement was achieved at a net carbon reduction and that the system's quality of wash water does not acidify the ocean or discharge secondary pollutants or harmful substances into the sea.

Tests on the *Coral Sea*, approved by the American Bureau of Shipping (ABS), apparently showed that at a rate of 33 tonnes/hour the CSNOx system could remove 99% of SOx, 66% of NOx and 77% of CO_2 from the exhaust emissions.

"Such results are achieved without any chemicals being introduced. Instead, Ecospec's patented Ultra Low Frequency (ULF) wave electrolysis treatment is utilised with all results verified by ABS," said the company.

Somehow, in around 2015 it all started to go wrong for EGT. Most recently, accounts from Singapore say the company could be

wound up this year, with unconfirmed reports that litigation is pending from the Finnish wood and paper supplier Stora Enso for US$1.38m for an exhaust gas cleaning system that never operated at the expected levels.

A Stora Enso spokesperson responded to questions from CSI by saying, "we do not comment on pending legal matters".

Robert Allen, however, believes that the two-stage cleaning system developed by EGT is viable, with the SOx cleaned in the first stage and then, when the SOx, which is 50 times more soluble in water than CO_2 and NOx, is removed then other pollutants can be removed without the SOx overwhelming the system.

However, as Allen pointed out at the CSA conference, the system did not specify the level of power used for the electrolysis used to produce the alkaline water for the cleaning process. Was this Stora Enso's complaint? *CSI* is uncertain. However, Allen has developed the two-stage idea and found a method of producing alkaline water that does not require electrolysis and has, therefore, a much lower operating cost.

Open loop scrubbers rely on the calcium carbonate in sea water to neutralise SOx, sea water contains around 400ppm of calcium and 145ppm of bicarbonate, so large volumes of sea water are required for the scrubbing process, according to Allen. Closed loop scrubbers use sodium hydroxide, says Allen, in fresh water to create the alkaline solution required to neutralise the SOx.

However, alkaline water can also be produced through the dissociation of water to hydrogen ions, H_30, and hydroxide (OH) ions, with no chemicals involved. Electrolysis is the most common method for dissociating water. But tourmaline crystals can also do the job.

Tourmaline crystals are a comparatively old concept. The crystal has a very low electrical charge of about 0.06mA, according to Japanese researchers in the 1980's. One of the researchers, Tetsujiro Kubo, found that however small the tourmaline crystals were ground, the charge remained, with the crystal capable of conveying an electrical current, with a positive and negative electrode at both ends of the crystal.

Kubo, in fact, took a series of patents out on the use of the crystal between 1996 and 1998, which are still valid. Uses for tourmaline can already be found, although not in a marine setting. Allen points to a flask with a cage inside containing tourmaline crystals encased in ceramic balls, between 3-5mm in size, which can, apparently, be bought from the Amazon website. In addition, UK newspapers were recently advertising a showerhead that uses tourmaline to improve the flow of water and offer purified H_20 that cleanses the skin, too.

Tourmaline is out there and the fact that the crystals produce alkaline water shows that it works, according to Allen. By using the tourmaline in ceramic pellets, an electro-magnetic field is generated that dissociates water, generating OH, which produces alkaline water, at around pH 9.2-9.5.

> *"For Allen, the testing of a tourmaline scrubbing system is necessary at a large scale to prove the system works"*

By using tourmaline crystals to produce the alkaline water necessary for the emissions abatement process within the EGCS the power take-up from the system is substantially reduced. In Allen's opinion, this new development would allow Ecospec's two-stage cleaning system to operate at viable efficiency levels, with all the additional benefits that the company claimed on NOx and carbon reductions too.

Tourmaline is readily available from Brazil, Russia, the US, Burma, China and parts of Africa, and the crystals are put to a number of different uses including environmental protection, medical care and electromagnetic shielding, among other things.

For Allen, the testing of a tourmaline scrubbing system is necessary at a large scale to prove the system works. He has already managed a small-scale test of the scrubbing system, which shows that it can work. However, there is a requirement for funds to upscale the system design in order to be able to test the cleaning potential on emissions in much larger quantities — the sort of quantities found in aframax vessels, or even larger.

Small scale testing, by Allen, showed that the tourmaline crystals were capable of producing four litres of pH 9.5 water in 10 minutes using 24 watts of electricity to pump the water.

"By scaling up this simple test rig it was estimated that 20m3/hour of water with a pH of 9.5 could be generated on-board a ship at a cost of less than US$10/hour," says Allen.

In total, Allen estimates that the cost of a scaled-up version of his tourmaline rig, pumping $20m^3$ of water/hour would cost US$7/hour and that the tourmaline necessary would be 70kg, which would be US$0.50/hour, totalling US$7.50/hour.

Allen says that he has now moved on to other technologies, but the research and development into the tourmaline scrubber that has been completed remains and he believes that a designer could and should pick up the mantle to take the two-stage scrubber technology to the next stage.

He acknowledges, however, that some major questions remain. Replication of the test rig results would need to be verified and that requires engineering and funding, probably from a recognised organisation or company, in order for the large-scale testing to take place. That would also require a company to build and install a test scrubber. Again, he acknowledges these are "big ifs". But the pay-off could make it a risk worth taking.

VEROLME MARINE SERVICES: FROM SCRUBBER MAINTENANCE TO GLOBAL ASSISTANCE

When the new sulphur cap regulations became mandatory on 1 January this year, many expected all kinds of problems: not enough compliant fuel, understanding the changes from one fuel to another, engine and scrubber system failures, and so on. As the vessel operators were well prepared, the transition in general went smoothly.

Not that the introduction of the IMO 2020 sulphur cap has been all plain sailing — far from it.

In the main, though, operators agreed to share and exchange experiences, problems and solutions related to scrubber installation, operation and regulatory aspects, as well as discuss topics of interest and initiate joint investigations and data collection, and to jointly approach manufacturers and suppliers to resolve any technical issues and improve exhaust gas cleaning system (EGCS) performance.

According to the Clean Shipping Alliance 2020: "Members of CSA 2020 are advising those shipowners looking to install marine EGCS as way of meeting global sulphur cap requirements to ensure that manufacturers, shipyards and installers are using quality, high-end materials. Based on the collective experience gained from more than 1,500 EGCS installations, CSA 2020 members found the quality of materials and coatings used is the most important factor in optimising EGCS safety and averting any corrosion problems during operation.

"Risks can be mitigated, by investing in quality materials, established suppliers and experienced installers, and by optimising machinery space layouts."

However, we have to also consider that, looking at the first months into the year, one of the largest disruptions was the significant cost savings that scrubber-fitted vessels benefit from, with a fuel price of more than $300/mt between heavy fuel oil (HFO) and very low sulphur oil (VLSO) as of January 2020. In particular, larger vessels could count on important cost savings each day.

The fact of important cost savings has been one of the most, if not the most important factor in the decision-making process to invest in scrubbers, in order to meet the sulphur emission regulations in 2020.

Scrubber installations have seen an exponential growth over the past few years to meet the January 2020 deadline, which has given rise to various bottlenecks in manufacturing, yard installations, retrofits and commissioning activities. Last year also saw a rapid increase in on-board emergency assistance.

In the past six months, the Verolme Service organisation has performed many different and unforeseen repairs on scrubber systems. We have been able to identify critical points and repeated issues for scrubber systems (including cracks in the scrubber body, leaking drain piping and corroded overboard piping) and have developed a periodic inspection programme in ports — a scrubber health check — and a (preventive) maintenance service programme.

Quality, high-grade materials, experienced manufacturers, auxiliary equipment from quality suppliers and experienced installers determine the risks and system up-time of a scrubber system. The chain will only be as strong as its weakest link and this will determine the system performance and

required efficiency over time. Cost-conscious owners invest in a scrubber system with a competitive price and low operating expenses.

Most scrubber systems have only been installed in vessels in the past few years and, for many owners, the real test of operating systems full-time started this January. There have been some teething problems and designs have not been fully developed from the start, with modifications to the initial installed systems are still ongoing as problems emerge.

Verolme's Business Development Manager Willem Kemps is keen to point out: "As an independent manufacturer of large marine scrubbers, working on installed scrubber systems on-board vessels is a natural move for us as we are manufacturers and specialists in welding special alloys.

"Our maritime origins, recent maritime projects, geographical position and strategically placed workshops, give us a strong platform for global agreements to manage maintenance of scrubber systems and maximise system uptime."

Working with the thin walled alloys and materials in this corrosive environment is not for everyone and a proven ability and qualified teams are key to maintain the high standards set by the industry.

We strongly believe the industry needs to understand and react on current problems and be supported by a (preventive) risk and data-based maintenance programme, which not only minimises down-time, improves efficiency — life-cycle management — but also provides a prediction of the real operating expenses.

WHY CHOOSE VEROLME SERVICE?

Replacement and spare parts of critical components system performance check: base line and periodical inspections by an experienced engineer to assess the overall status of the system, mapping of critical components, suggest possible corrective actions or maintenance operations to sustain the required performance and highest efficiency standards over time.

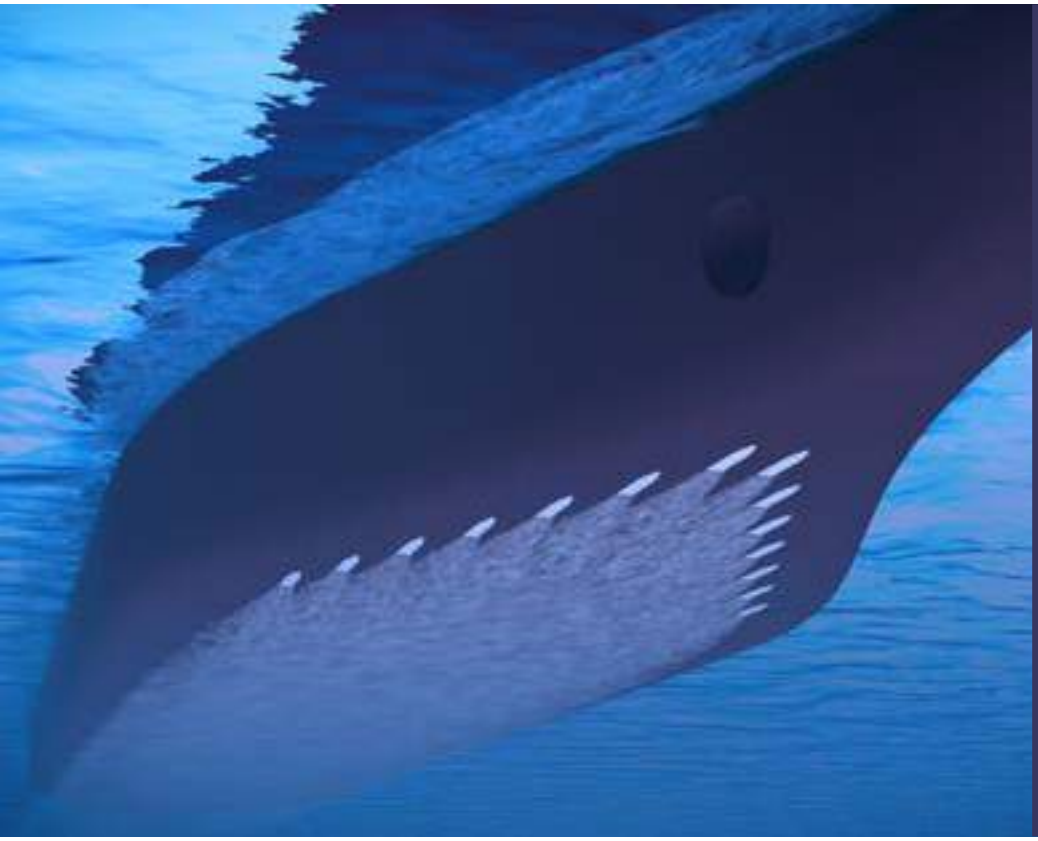
Global presence, quick assistance and strong global partner network: claim and warranty-related matters. Support with scrubber system-related yard assistance, GRE pipe repairs and modifications, installations and calibration activities through our strong global partner network.

Alloy experts, spare parts and design support: we can provide scrubber detailed parts design and material upgrades with our expertise in corrosion-resistant materials and repair experience on scrubber systems. We have approved design for overboard piping and supply and discharge spool design. Materials range from 316, SMO, super duplex to titanium. We have typical parts availability in our warehouse, approved overboard pipe design with various diameters, water supply and discharge piping parts.

The maritime industry is encouraged to reduce its environmental footprint and our expertise and risk-based service aims at reducing emissions to air and sea. We are committed to reduce downtime and repair needs for our clients, with innovative risk-informed and data-based concepts developed to a "fit-to-purpose" inspection and maintenance programme. We strongly believe that scrubber systems represent an opportunity and a step towards greener shipping, and we want to contribute to a more sustainable shipping industry.

VEROLME®

For more information, contact:
w.kemps@verolme.com
ticco.maagdenberg@verolme.com
+31 88 0067400
Komeetweg 4
4782 SG Moerdijk
The Netherlands
verolme.com



Air lubrication systems are the way forward, according to the CEO of Silverstream Technologies, who tells *CSI* how such systems offer sustainability and savings

Noah SIlberschmidt, CEO, Silverstream Technologies

SAILING ON AIR

Even after decarbonisation takes place within the maritime sector, ship operators will want to operate at maximum efficiency. That means systems that cut emissions by reducing the amount of fuel used, such as Silverstream Technologies air lubrication system, will remain an integral element of ship design and construction, according to a senior Lloyd's Register technician.

It is a view that is, no doubt, shared by Silverstream Technologies CEO Noah Silberschmidt, who tells *CSI* that the target market for Silverstream's air lubrication system stands at 12,000 ships and that would include vessels under 12 years old and larger than 180m in length, with up to 600 new ships a year also coming into that remit.

Silberschmidt boldly predicts that in five to 10 years' time all vessels of a certain size will be fitted with an air lubrication system. The CEO said that while IMO2020 was helpful for the company, it is the Energy Efficiency Design Index (EEDI) that "makes it difficult to build a new vessel without a variety of technology on board". He adds: "You can't build ships like you used to, you need to incorporate proven technology".

In addition, he believes that by 2050 vessel owners will want a complete solution that will include waste heat recovery systems, battery power and air lubrication.

In preparation for what Silverstream expects will be a surge of orders, the company has entered into a licensing and service agreement with Wärtsilä, giving Silverstream's customers access to the Finnish company's global service network.

"It understands the need to integrate a variety of technologies to improve the performance of a ship for the client. It has the vision to see this through and is looking at making the system better and cheaper for the client," explains Silberschmidt.

Currently, Silverstream's fleet consists of 12 vessels, nine Grimaldi ro-ro ships and three Finnlines cruise ferries. But the orderbook consists of a variety of vessel types, including large LNG carriers,

cruise vessels of between 115,000 and 170,000gt, ro-ro vessels and dry bulkers, with four newbuilds and three retrofits.

In the future, the company expects orders for more cruise ships to be added and is in discussions with dry bulk, liquid bulk and LNG carrier operators. But the real prize for Silverstream is to attract large container vessels.

It is easier to get a return on investment on a fast-moving vessel, points out Silberschmidt, rather than ships that spend lengthy periods at anchor or in port. Having a ship that is constantly moving is just one of the necessary pillars on which the economic case for air lubrication is built on.

"No-one expects the price of oil to stay low," says Silberschmidt, landing a direct hit on another economic pillar, with the price of oil showing huge swings in the first quarter of this year due to covid-19 and the ensuing slump in demand, but also the dispute between Saudi Arabia and Russia over oil production that has seen the oil producers ramp up production even when faced with serious consumption issues.

Oil will not be the only fuel in the future, however, and it is the price of all fuels that will need to remain high to make the economic case for technology that offers fuel consumption efficiencies.

Silberschmidt is looking forward to a world where all companies and consumers accept that technology must be sustainable, "All companies want to be environmentally sustainable," he says. "There's been a shift from 10 years ago, an acceleration towards sustainability over the past two to three years".

For Silberschmidt, that sustainability will come through technological advances such as Silverstream's air lubrication system, which he says will produce net savings in fuel consumption of 6% to 11%.

The system works by using a unique air release system with 3-4m long steel constructions that are integrated into the flat bottom of the ship. Compressed air is pushed out from the hull through outlets located at keel depth and forms an air lubrication layer between the hull and sea water

The Kelvin-Helmholtz effect, where the movement of the air and water at different speeds causes turbulence and drag, is thereby reduced. "By having air introduced at hydrostatic pressure, water is pulling air in a micro-bubble format, a smaller volume of air is used, at lower pressure and so less energy is required," explains Silberschmidt.

That means the system uses smaller compressors than other systems and it has a smaller footprint, with reduced vibration and noise levels as well as using only 2% of the main engine power, while reducing the fuel consumption by up to 11%.

Testing of this system took place on a 180m Shell-owned tanker that operated at 14kn and with a 10m draught. The tests were conducted in 2014 and consisted of 26 double runs completed to ISO standards, with wind and waves the same. All parties agreed on the data sets and there were strict parameters to adhere to that were decided before the tests took place. The standards for testing procedures were improved using input from a global industrial alliance, which included 18 private companies such as ship operators Maersk, MSC and Shell, as well as technology companies such as ABB and Wärtsilä.

"We had a better framework for testing because in the past there were no rules on what you were allowed to claim for your technology," claims Silberschmidt. That meant that Silverstream had explained carefully what the base case for the system was and that was different to the testing applied to other systems.

According to Silberschmidt, all three major South Korean shipyards have produced air lubrication systems, but they have not managed to get the same level of orders as Silverstream.

"We can see the interest from clients," he says. "We have a number of testimonials from clients such as Carnival, which published its results in 2018, showing the system is performing to a higher standard than had been claimed by us."

Ordinarily, that would mean that the period for achieving a return on investment (ROI) would decrease, but with the price of oil currently at such low levels, and the price of bunker fuel too, the ROI.

Silverstream acknowledges that getting a precise ROI is difficult with the cost of fitting an air lubrication system varying substantially depending on the vessel type and design and whether the ship is a newbuild or retrofit.

However, it is acknowledged that the volatility in the oil market could extend or shorten the payback period for all vessel designs, whether they are one of the newbuilds or retrofits in Silverstream's orderbook.

As time passes, flexibility in delivery times for equipment will reduce, as will availability of shipyard space and installation contractors. Getting the engineering phase underway in advance allows shipowners to plan equipment purchasing and installation in a timely manner

TIME FOR A CHANGE

by Ben Myers, Project Director, Houlder

Shipowners found themselves boxed into a corner when it came to scrubber installations ahead of the IMO2020 low sulphur fuel requirement deadline, when installation was a choice. But ballast water treatment systems (BWTS) are mandatory.

Significant time has been spent preparing for ballast water regulations, which affect roughly 80% of the global fleet. And while the US Coast Guard (USCG) has published a bulletin detailing the circumstances under which it will consider extending the deadline for ballast water treatment compliance, wider extensions will depend on individual flag states.

Therefore, while the industry is slowing due to the impact of covid-19, the rolling IMO installation deadlines up to September 2024 are highly likely to stand firm. Optimising investment and installation dates, therefore, remains tricky. It's time to get real and use the remaining time available to make informed and valuable decisions.

Meeting the requirements of the Ballast Water Convention has always been a huge task for the industry, particularly as ballast water treatment retrofit projects could be quite significant — from the project size, installation and design requirements to the pricing and continued servicing. This underlines the need to look ahead and plan a realistic time frame.

Vast numbers of ballast water treatment systems are available and deciding which one is right for a particular vessel is challenging enough, even before installation and engineering is considered. As installation of systems is expected to peak in 2022, shipowners and operators need to be aware that — although cash flow is likely to be a challenge over coming months — by taking a phased approach; the cost of the overall installation project can be spread out over time, enabling greater flexibility and options along the process.

Owners and operators need to decide where and when to invest their capital in these circumstances — it is an already complex decision without the addition of the current pandemic thrown into the mix.

© Houlder

Owners and operators would do well to look ahead. And not just at initial cost outputs, but also at the future operational considerations of systems beyond what is offered by the type approval certificate.

EXPERT PLANNING

The value of impartial advice cannot be underestimated. Factors such as vessel design, ballast pump flow rate, availability of space and power supply are all factors to be considered when making a prudent choice of treatment system. Shipowners and suppliers can maximise efficiency and cost benefits by working with an independent partner on both sides of the specification and installation process.

Early investment in obtaining expert engineering advice is a small cost of the total job, but planning the project in its entirety can make a significant impact, saving time and money and reducing problems further down the line.

Owners and operators are not always aware of realistic project timescales. Those expecting retrofit projects to be delivered from planning to commissioning in less than six months may get a rude awakening. For example, equipment lead times are typically a minimum of three months, depending on the system, supplier, delivery location and increase as demand peaks.

All the stages of the process need to be taken into account, including class approval, availability of commissioning engineers and dry dock availability. Planning ahead is vital, particularly at this crucial point within the Convention timeline.

An early feasibility study of the vessel can take place without visiting the ship. This not only allows a clear review of both Opex and Capex costs to get a true and independent upfront cost comparison for shipowners and operators, but also a clear idea of the equipment decisions and process ahead. The sooner this takes place, the easier it is to plan the retrofit.

The challenges circling compliance with the Ballast Water Convention are twofold for both suppliers and shipowners. The first is in understanding the needs of each vessel and making sure they are offering the correct and complete services to their client. And the second is in ensuring the timely and cost-effective installation of BWTS in accordance with the upcoming deadlines and their own environmental guidelines.

Independent expert advice can assist shipowners and operators in managing requirements and budgets efficiently and effectively. This ensures the full picture is being considered straight out of the starting blocks.

UNDERSTANDING VESSEL OPERATIONS

One of the most important phases to get right early on in a BWTS retrofit project is to truly understand the vessel's operations, as this will lead to correct system selection and specification. For example, vessels operating in freshwater environments, particularly in polluted waterways, need to consider this when choosing a ballast water treatment system as — depending on their choice — some tank modification may be needed. If an electrochlorination (EC) system is chosen, one of the existing tanks may need to be modified.

A seawater storage tank will be needed to feed the treatment plant when it is operating in a freshwater environment, as all EC systems require the feed water to have a minimum salt content to generate sodium hypochlorite. The extent of the modification and the required tank capacity depends on the operational profile of the vessel and the specific system to be installed. As a rule of thumb, the side stream EC systems require 1% of the ballast water flow to feed the electrolyser, which means to treat 50,000m³ of ballast water the tank capacity would be 500m³.

This is just one of numerous examples and illustrates the importance of taking time to fully understand the vessel's requirements and how these effect equipment selection. It is this that will protect owners and operators in the long term, ensuring they are investing in the right equipment and using it in the right way.

AVAILABLE SYSTEMS

A variety of technologies are available in the market. Constraints such as availability of space, cost of implementation, and level of environmental friendliness play an important role in selection. Some of the main factors include the effectiveness of the system, safety for the crew, ease of installation and space onboard.

Individual systems also come with a list of system design limitations (SDLs), attached to type-approval certificates. Key factors that can significantly impact operational efficiency can include turbidity, salinity, temperature and holding times, all of which have the potential to reduce the effectiveness of the treatment system. Owners and operators need to ensure that they are aware of these factors to ensure they fall in line with the planned operations for their vessels.

Additionally, on most vessels there is no existing space or consideration for ballast water treatment, which in turn means each solution needs to be tailored to the vessel. Each retrofit involves working with an engineering department and a chosen yard to provide services such as 3D scanning and drawings for class approval. The value of meeting an existing docking schedule or arrange for installation during a particular voyage cannot be underestimated.

Working with a partner that can provide flexibility and adapt to a project if trading routes change prior to docking is fundamental to the delivery of a smooth and successful project, even when major changes occur.

Importantly, finding an installation partner who is vendor agnostic will ensure the maximum value can be gained from the project and decisions made in the client's best interests.

PREPARATION AND INSTALLATION

Some surveys can be more demanding due to the size of the vessel and the presence of hazardous zones. This is particularly evident with tankers requiring 3D scanning. 3D scanning allows the team to model the new equipment in the area planned for installation, to ensure that there is sufficient space to manoeuvre and install the system. This significantly reduces the time involved during installation, guaranteeing the area and location of equipment agreed between the client and the vessel personnel.

The use of 3D scanning also requires a hot work permit and some terminals can be hesitant to give permission to conduct 3D scanning when the vessel is at their facilities. Although there are EX-proof scanners, their significant size and weight makes it almost impossible to use them in the marine environment. To get around this problem, engineers should board the vessel after it has discharged its cargo and is gas free.

Due to the time it takes to complete, it is best if the approximate location of the equipment is agreed with the client and the vessel personnel before the survey team arrives on board to ensure maximum efficiency.

MEETING THE DEADLINE

In meeting the compliance deadline, it is particularly important to plug knowledge gaps between shipowner and BWTS supplier. This enables suppliers to take reliable ownership of the operability of their systems regardless of the specification of the vessel and grants peace of mind to shipowners concerned about their liability for non-compliance. Countering challenges effectively will also require access to limited specialist resources and expertise at every stage of the project and beyond.

Given the complications with fitting a BWTS, it is essential that specialist engineers are part of the process from the beginning. This ensures the system's installation can be engineered, approved and executed in the most effective and efficient manner. It is also important for equipment suppliers, regulators and other stakeholders to work together and ensure the engineering and technical advice being provided is accurate and timely for the industry as a whole.

With the deadline looming — and extensions unlikely — it is essential for owners and operators to make informed and timely decisions. Leaving it too late risks problems further down the line, compromises flexibility and choice, and adds additional cost to the overall project. Time spent in reconnaissance is seldom wasted. And ballast water treatment is no exception.

DATALINK: KEEPING A CLOSE WATCH ON WATER

Datalink Instruments (DTLI) has been designing and manufacturing highly reliable, low-maintenance and cost-effective online water monitoring solutions since 1989. We offer a wide range of water analysers and probes that use the very latest technology and are suitable for a number of applications, including scrubber washwater quality monitoring, drinking water, waste water and ground water monitoring, environmental monitoring and refineries.

Instrumentation shelters

CASE STUDY 1

An alternative technology to monitor ammonium

A global firm specialising in fertilisers has a plant producing mainly ammonium nitrate. It needs a reliable system to monitor ammonium in its waste water (around 200mg/L of NH_4^+).

The waste water is discharged in the sewage network and then treated by a public utility company, which charges the client depending on factors including ammonium concentration.

The company needs to independently monitor the ammonium load of its effluent in order to challenge the data from the sewage company, therefore keeping control of both costs and processes.

The AM200 was installed at the discharge point, to replace a former ISE analyser that was not considered reliable. The laboratory validated the measurements and approved the AM200 for online ammonium monitoring, comparing laboratory measurements of the same samples.

The AM200 measures ammonium (NH_4^+) thanks to an innovative technology that uses gas spectroscopy. For each measurement, the amount of NH_4^+ within the sample is turned into ammonia gas (NH^3) in order to be analysed.

The analyzer is calibrated for a 0.2-1000mg/L NH_4^+ measurement range. It is housed in a small shelter where the sample is available at atmospheric pressure, after gross filtration in a small tank. The AM200 collects each sample with its optional sampling pump. It performs a measurement every 15 minutes and transmits the analysis result to a Distributed Control System (DCS) through its 4-20mA output. The DCS activates an alarm at 80/90% of the range and the system has been designed to divert the water towards a side storage tank in case of threshold alarm activation.

Installation of the AM200 inside its shelter

Client feedback

Besides the reliability of the measurement, the client appreciated that "the AM200 analyser is very simple to use, uses no expensive reagent (only caustic soda) and does not need much maintenance."

AM200 in brief

0.1–20mg/L NH_4^+
0.2–1000 mg/L NH_4^+
Measurement time: 3 minutes
Chemical self-cleaning system
Consumables: diluted caustic soda as a reagent and sulphuric acid for the cleaning system.

CASE STUDY 2

Optimising the cost and reliability of the coagulation step in drinking water

Drinking water plants use coagulant to remove the Natural Organic Matter (NOM) dissolved in raw water.

The amount of NOM can vary depending on the weather or other conditions, and the coagulant injection flow must be adapted quickly to maintain the efficiency of the treatment.

With manual measurement, there can be a delay between a pollution peak and its detection, which can prejudice the quality of the water produced. On the other hand, when the NOM decreases, too much coagulant might be injected.

Automating the coagulant dosing can solve these issues.

For surface water, the optical density at 254nm is approximately proportional to permanganate oxydability, as measured in the laboratory. The Specific Absorption Coefficient at 254nm (SAC254) measurement, expressed in m-1, determines the concentration of Dissolved Organic Carbon (DOC) in the water (humic and fulvic acids).

The solution

Every 15 minutes, a CT200 analyser measures the SAC254 on untreated water entering the plant. The CT200 directly controls a dosing pump through its 4–20mA output.

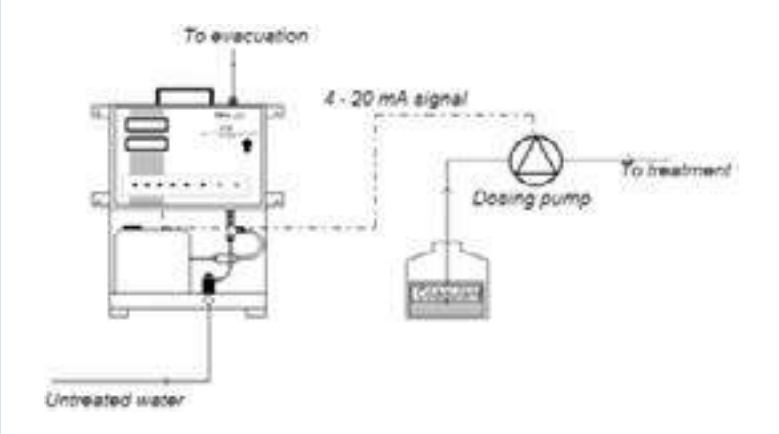
Thus, the system adjusts the flow of coagulant in real time, according to the organic matter content in the untreated water.

CT200 in brief

- No operator work
- No reagent
- No electrode
- Self-cleaning system
- Long product lifecycle
- Time-saving: no operator needed to collect, analyse samples and adjust the injection flow
- Money-saving: only uses the needed amount of coagulant. No alum overfeed
- Full-time quality control of the production.

For more information, visit: datalink-instruments.com

The CT200 in situ



The CT200 at work

How can shipowners ensure the operability, reliability, accuracy and — most importantly — compliancy of their ballast water management system?

CUTTING THE HIDDEN RISKS

by Emma Johnson, Maritime Sales Manager, Chelsea Technologies

On paper, it's easy to think that Ballast Water Management Convention compliance is as easy as installing a certified ballast water management system (BWMS) and training a crew to follow the convention's processes.

Certainly, when BWM systems represent a huge capital investment in order to be compliant, many hope that they are shielded from risk. However, this is only half the battle; technical or crew failures can easily leave a shipowner liable, despite their financial outlay.

The BWMS market has grown rapidly over the past few years and an increasing amount of systems are available for shipowners, naval architects and system integrators to choose between. There are currently more than 100 different BWM systems on the market, from dozens of manufacturers and each is operated differently. All of these are certified by either the USCG or the IMO, or both, and each works in a different way.

Big differences between BWM systems are, of course, easy to spot. An operator will be able to tell if their system uses chemical solutions or UV to treat the ballast water and it is clear that crew training would have to be on that type of system. However, operators may find the subtle differences in processes and operational requirements between systems of the same manufacturer more difficult to spot and it is those differences that are just as likely to cause incidents of non-compliance.

With training and operability requirements already potentially confusing, operators may look to the data that their BWMS produces to ensure compliance — and flag up when they are non-compliant. By regulation and by design, all systems must produce and record key functionality data. However, it says little about compliance.

No BWMS currently on the market tests the ballast water and no BWMS can tell you that the water is actually being treated to the correct standard. The data produced by the system only shows that it is turned on and functioning, but there are a multitude of errors or malfunctions that

"While the IMO is still formulating a ballast water compliance testing process, many in the industry believe that crew competence will be the next area of non-compliance that port state authorities will focus on"

could affect the treatment of water without being picked up. Even then, there is no requirement that this data be used by the ship's crew to ensure operational compliance and, even if it were to be used, it can often be difficult to understand.

UNDETECTED FAILURE

A study of BWM systems last year found that several were being fitted incorrectly and that a simple and undetected failure meant that an otherwise operational BWMS was not working as it should. These systems would often provide data that made it appear as though they were working, meaning that a crew member that was properly performing every stage of the operational processes recommended by the manufacturer would be given no indication that the overboard discharge was non-compliant.

Regulators have recognised this and have put in place a robust framework to ensure that shipowners can be confident that their BWMS works upon commissioning.

Earlier this year, the Pollution Prevention and Response subcommittee of the International Maritime Organization (IMO) passed an amendment to regulation E-1 of the Ballast Water Management Convention, which is expected to be adopted by the Marine Environment Protection Committee later this year. The amendment seeks to provide shipowners with a greater level of certainty at the point a BWMS is fitted.

Careful not to duplicate the type approval testing regime, this amendment requires operators to conduct commissioning testing using indicative means only. The 10-50µm and >50µm size classes of organisms will be the focus, with no requirement to test for indicator bacteria during the commissioning test.

The results of these tests will be compared against the IMO standards for different sizes of organism, in order to ensure that the treatment system installation is able to treat ballast water to a compliant level in situ.

Using this new commissioning testing framework, shipowners can now be more confident that their BWMS works aboard their ships immediately after commissioning. The kind of errors we saw in installation should be easier to prevent once these standards have

been adopted, because indicative commissioning testing flags installation issues and ensures that they are rectified during the commissioning phase. However, it does not mean that shipowners can be confident that their BWMS remains operationally compliant beyond that point.

MAINTAINING COMPLIANCE

As systems age and become subject to onboard planned maintenance regimes, there is an increasing likelihood of sub-standard performance from treatment systems.

This is compounded by obvious difficulties detecting issues; a visual inspection of the ballast water, or a data readout that doesn't note a fault, provides no guidance for a shipowner in ensuring compliance.

This is especially true when an issue is caused by a damaged filter or a broken sensor. Unbeknown to a shipowner who expects to be compliant, ballast water may not be treated at all or may be treated to a level that is not sufficient to satisfy the regulations.

If a BWMS is damaged, or suffers from a technical failure, there is no guarantee that any data it produces will show that it is not functioning as designed. Depending on the fault, all readings may look as though a damaged system is fully operational and compliant. In these circumstances, port state control and enforcement surveyors are the most likely party to discover an issue, unless ship operators invest in an ongoing monitoring process.

Human error factors may be an even more pressing concern. Confusion over the type of training required for each of the 100 systems on the market, as well as administrative issues maintaining knowledge as crews change ships and systems, has highlighted additional risks. In parallel with a high demand for training, this has created a difficult landscape for operators.

Crew following an incorrect procedure that they believe to be correct may not be able to spot non-compliance. Should the data provided by a BWMS incorrectly suggest that there are no issues, or that data be read incorrectly, another opportunity to find and rectify non-compliance is missed. Confusion about training makes it incredibly easy to miss non-compliance until it is too late.

While the IMO is still formulating a ballast water compliance testing process, many in the industry believe that crew competence will be the next area of non-compliance that port state authorities will focus on. Inadequate or inappropriate crew training leading to non-compliance is easily provable "low-hanging fruit" for regulators, when training is within the control of the operator.

Both of these factors have a sizable impact on the industry. The sheer scale of accidental non-compliance was demonstrated last year, when Anglo-Eastern managing director Carsten Ostenfeldt explained the problems that they experienced. Of approximately 210 Anglo-Eastern ships fitted with one of 19 different models of BWMS, he said that every single one exhibited some issues during the first year of use.

SHIPOWNERS FACE RISKS

Excess risk is particularly unwelcome in shipping at the best of times and ballast water regulations are clearly creating a new strand of risk for shipowners to mitigate.

For some, the first question to ask will be on insurance: what kinds of breaches, if any, will insurers consider to be within their cover and how many costs will be recoverable?

We do not yet know how insurers will treat accidental ballast water non-compliance. Until we have clarity on ballast water compliance testing, including what processes will be used and how long it will be permitted to take, there will be large unanswered questions.

Insurers could set new standards for training and monitoring, but it is clear that there will be large unrecoverable losses for non-compliance anyway. Shipowners face huge financial risks regardless of what regulators, insurers and courts decide.

The only effective way of mitigating this risk comes in the form of rapid, on-board indicative compliance monitoring that provides a lab-accurate assessment of ship's ballast water discharge against the D-2 regulatory standard. This is the only information that can tell operators and crews if their BWMS is fully operational and compliant, and therefore if any maintenance or support is needed to avoid a non-compliant discharge before a shipowner is liable for a fine.

Indicative testing cuts risk, but only if crew can operate and understand the test. Crew training is complex and expensive, and any test that is difficult to carry out is a hindrance to compliance. It is imperative that indicative testing is simple enough not to require extensive crew training.

UNIQUE MEASUREMENT

Operability, reliability and accuracy were the core principles that Chelsea followed when developing FastBallast. The system integrates a sophisticated measurement technique with a convenient, portable and user-friendly instrument.

The unique measurement technique provides a high degree of accuracy within an indicative result on discharge compliance. A high degree of automation and an easy-to-understand user interface means that it can be operated with little to no additional training.

Ballast water regulations are still evolving and as they do, it is natural that new issues cause concern and debate. Shipowners have moved from ensuring that systems work upon commissioning to ensuring that they maintain operational compliance.

It is important that, when incomplete or mis-leading data poses a hidden risk, indicative testing can highlight these problems quickly and empower shipowners and other stakeholders to act early.

The hidden risks of the current global regulatory regime on ballast water management could easily come back to bite any shipowner, especially those who do not do all they can to mitigate risks today.

The best way to cut these hidden risks, if IMO or United States Coast Guard, is to employ easy-to-operate onboard indicative compliance monitoring.

The low-carbon shipping outlook suggests industry will need to do more to meet GHG targets. In its recent report, *Pathways to Sustainable Shipping*, ABS sets out the course that shipping needs to take to achieve its carbon targets. Report contributor Georgios Plevrakis gives *CSI* an incisive precis to this 107-page analysis

LOW-CARBON CHALLENGE

by Georgios Plevrakis, Director of Global Sustainability, ABS

International shipping is facing the critical challenge of sustainability in response to global regulations for pollution prevention and protection of the marine environment.

During the past 30 years, the enacted regulations were shaped in equal parts by responses to environmental incidents, disruptive periods of technological innovation and changing priorities among marine regulators, all of which were intended to improve operational efficiency, protect the environment or enhance workplace safety.

Each new regulatory development was preceded by long periods of industry investigation and discussion, and then followed by extensive efforts from the International Maritime Organization's (IMO) Marine Environmental Protection Committee (MEPC), to achieve the IMO's strategic objectives through effective technical regulations.

As the governing body on environment-related issues, MEPC has long sought to objectively address the environmental concerns raised by its member states and partner organisations.

In every instance — from IMO's mandate of the double-hulled oil tanker design and onwards — the conception, formulation and, especially, implementation of regulations would have been greatly aided by a comprehensive, living document that summarised the challenges and offered current solutions.

As no such document existed, the maritime industry has often experienced long periods of uncertainty as it sought to interpret the new mandates and harness technology to comply with those mandates.

As the industry adjusts to the current impact of IMO's 2020 sulphur cap — and prepares for the emerging regulatory changes in 2030 and 2050 — there is consensus that adapting to the new rules and challenges aimed at lowering its collective carbon footprint will be another period of uncertainty driven by disruptive environmental legislation,

and defined by the innovative solutions that emerge.

While reducing carbon dioxide (CO_2) and other greenhouse gases (GHG) is a separate challenge from current efforts to lower shipping's output of pollutants such as nitrogen oxides (NOx) and sulphur oxides (SOx), both put the health of the environment and the livelihood of those who depend on them at risk. For shipping, a "zero-carbon future" is an aspirational goal and the associated regulatory pathways will evolve alongside the changes it inspires in ship design, technology and practices. Importantly, progress must be achieved strategically and holistically if the maritime industry is to emerge more efficient, profitable and sustainable than it is today.

In recognition of this goal, ABS has developed the second in a series of *Outlook* documents — the first was published in June 2019 — to reference available carbon-reduction strategies and inform the shipping industry as it enters the uncharted waters of the 2030/2050 emissions challenge.

"For shipping, a 'zero-carbon future' is an aspirational goal, and the associated regulatory pathways will evolve alongside the changes it inspires in ship design, technology and practices"

The document examines how the development of global trade will impact global emissions.

Furthermore, it identifies the three main fuel pathways on the course to meeting the IMO's emission reduction targets for 2050 and beyond: light gas fuels, heavy gas fuels and bio/synthetic fuels. It also examines the possible capacity demand and related emissions output trends on a global basis to envision the environments in which those targets may need to be achieved. The report has been produced solely to help provide industry stakeholders with the information they need to make informed decisions.

The near-term challenges will require them to make choices between new fuels, energy sources and emissions control systems. The report is a tool designed to help shipowners understand the complexity of the task ahead and to move forward effectively as they assess their options for a transition to low-carbon operations, and to further the zero-carbon future of shipping.

REGULATORY EVOLUTION

With the IMO's marine fuel sulphur cap now in place and air emissions and GHG reduction targets set for the next 30 years, it is instructive to recognise how the shipping industry got to where it is and what is on the near horizon from a regulatory perspective.

At every step, industry stakeholders rallied to offer equal measures of inspiration, investigation, consultation and resource allocation to achieve the goals of each regulation; it is a formula and level of collective commitment that will need at the very least to be replicated as shipping sets course for a zero-carbon future.

One recent report estimated the industry would need to invest at least US$1tn to meet the IMO's emissions targets for 2050. From the GHG perspective, the IMO's most ambitious current target — to reduce shipping's GHG emissions by at least 50% by 2050, compared to 2008 — was agreed in April 2018 and for the first time brought the shipping industry broadly into line with the goals of the UN's Paris Agreement to combat climate change.

The IMO's initial strategy lists a number of candidate measures which could also be considered to further reduce emissions and help achieve the targets in the strategy, in particular the 40% reduction of carbon intensity from shipping by 2030.

Short-term measures could be measures finalised and agreed by MEPC between 2018 and 2023, although in aiming for early action, priority should be given to develop potential early measures with a view to achieving further reductions of GHG emissions from international shipping before 2023.

Proposals for a technical approach, which were discussed included an Energy Efficiency Existing Ship Index (EEXI), which could require ships to meet set energy efficiency requirements after the measure taking effect. Other technical proposals relate to mandatory power limitation on ships.

Operational approaches would include focusing on strengthening the ship energy efficiency management plan, as required in SEEMP. This includes proposals for mandatory carbon intensity reduction targets. Operational proposals also include measures to optimise speed for the voyage. Proposals to limit ship speed were also discussed.

Proponents of the various proposals were invited to provide further details on the initial impact assessment of their proposal, with a view to identifying the remaining issues to be further considered, including whether the proposed measure may generate a disproportionately negative impact on some states.

With a longer-term perspective, and in order to encourage the uptake of alternative low- and zero-carbon fuels in the shipping sector, the related Working Group also agreed on the establishment of a dedicated workstream for the development of life-cycle GHG/carbon intensity guidelines for all relevant types of fuels. This could include, for example, biofuels, electro-/synthetic fuels such as hydrogen or ammonia, etc.

More than 20 years since the IMO first began efforts to regulate the air emissions from the world's commercial fleet, the industry is now officially on an ambitious course to a zero-carbon future.

THE WAY FORWARD

ABS's *2020 Setting the Course to Low-Carbon Shipping — Pathways to Sustainable Shipping* outlook presents a comprehensive description of the three potential fuel pathways for meeting IMO goals to decarbonise the global fleet. It also offers key insights into alternative power generation systems, the evolution of global trade and its effect on fleet size, fuel consumption and emissions, operational measures to optimise vessel usage and reduce GHG emissions and conceptual designs and specifications for vessels opting to use alternative fuels and power generation systems.

The key conclusions can be summarised as follows:

» The three fuel pathways are: (i) light gas (ii) heavy gas-alcohol and (iii) biofuel or synthetic fuels. All three pathways start with fuels that can be used in existing power generation and propulsion systems and have a proven potential to reduce CO_2 and other regulated emissions.
» The use of low- and zero-carbon fuels is essential in the effort to reduce the carbon footprint of future vessels. The operational profile of each vessel will dictate the choice of fuel and propulsion system, based on requirements for bunkering and cargo capacity.
» Low- and zero-carbon fuels that have low volumetric energy content, such as methanol, ammonia or hydrogen, may require holistic redesigns of vessels to be used as primary fuels.
» Petroleum-based fuels are expected to have a considerable market share by 2050 (up to 40%), which makes the use of carbon capture and sequestration systems relevant not only for shore applications, but also potentially aboard marine vessels.
» Novel power generation systems such as hybrid diesel-electric or fuel cells have the potential to offer significant emissions benefits. The first applications of such systems are in specific vessel types, especially those that operate in environmentally sensitive areas such as ports. Their market penetration is increasing; however, wider adoption to larger vessels will require more technological innovation and the cost reductions associated with economies of scale.
» Decarbonisation of the global economy is likely to lead to profound changes in trade volumes and patterns in the full range of commodities transported by sea over the next 30 years. These changes will affect the evolution of the fleet and reduce certain vessel segments over the period to 2050.
» The transition to low- and zero-carbon fuels is likely to increase the cost of vessels and their operation in the medium term, until the associated technologies for fuel production, distribution, bunkering and onboard use become more cost effective.
» The anticipated alternative fuel and power generation technologies will require the adoption of new regulations, which in turn may affect cargo and trade volumes.
» New safety regulations also will be required to ensure the wide adoption of new technologies and operational frameworks that may not be covered by current standards.
» Based on the projected fuel mix for the five vessel segments analysed in the ABS study, shipping can meet the IMO's target to reduce CO_2 emissions per transport work (gCO_2 /dwt/nm) by 70% by 2050, relative to 2008. However, to achieve a 50% reduction in absolute CO_2 emissions (tonne), the market share of petroleum fuels will need to be further reduced by 2050 (below 40%).

Maritime's decarbonisation challenge can therefore be regarded as a complex riddle combining three elements: vessel energy efficient technologies, operational optimisation and low and zero carbon or carbon neutral fuels.

All elements have a role to play, but we have identified that the rate of shipping's transition to lower carbon fuels will have the single biggest impact on its global carbon footprint; more than any predictable shifts in commodity demand, enhancements to operating practices or vessel routings.

The models in the ABS research suggest the industry will meet the targets for the reduction in carbon intensity by 2050, but it might miss the target for the total GHG emitted annually. In short, there is a gap between the industry's present course, and its stated ambition; a gap which could be bridged through the help of accelerated decarbonisation policies that span across the value chain.

Innovation is widespread in shipping as the industry transitions to a low-carbon future. Here, we highlight the potential of carbon capture and explain how government funding is accelerating progress in research and development

OPPORTUNITY KNOCKS

by Rupert Hare, CEO, Houlder (top) and Paul Willson, Director, PMW Technology

The world is facing up to the need for huge changes in energy transition. And the energy and transport industries have a mountain to climb.

The commitments already made by the International Maritime Organization (IMO) for radical reductions in shipping emissions by 2050 are just the beginning for the shipping sector. They already require significant changes in vessel design and a potential paradigm shift in fuels and propulsion methods.

The long service life in shipping makes the challenge even more significant. It's not just a question of a new approach to the design of new builds, we also need a strategy for retrofit. There simply isn't the financial or shipbuilding capacity to consider wholesale early scrapping of otherwise serviceable vessels.

For shipping, the drive to decarbonise has instigated change unlike anything seen in the industry since the adoption of oil. Research and development efforts are generating optimism around zero carbon energy solutions such as hydrogen, renewable natural gases and battery power. And traditional wind power is being brought to the modern seascape through kites and rotor sail technologies.

Exploration of marine applications for carbon capture, has, however, been lacking. Carbon capture is already proving a challenge for large onshore facilities and the size, scale and technical challenges of current carbon capture processes have, to date, been even more difficult for the shipping industry.

Carbon capture from marine engines could offer shipping an alternative to the huge cost of creating a new supply chain for fuel production and delivery, as well as allowing the retention of current high-performance engine designs.

Perhaps, more importantly, it could offer a retrofit solution that would allow existing propulsion systems and fuel supply chains to remain in place for longer. It could offer the opportunity for ultra clean liquefied natural gas (LNG). Equally, its

applications and usage in the energy sector is developing with large-scale demonstrators and government programmes working with major players to implement substantial industrial clusters by 2030. Its potential demands consideration.

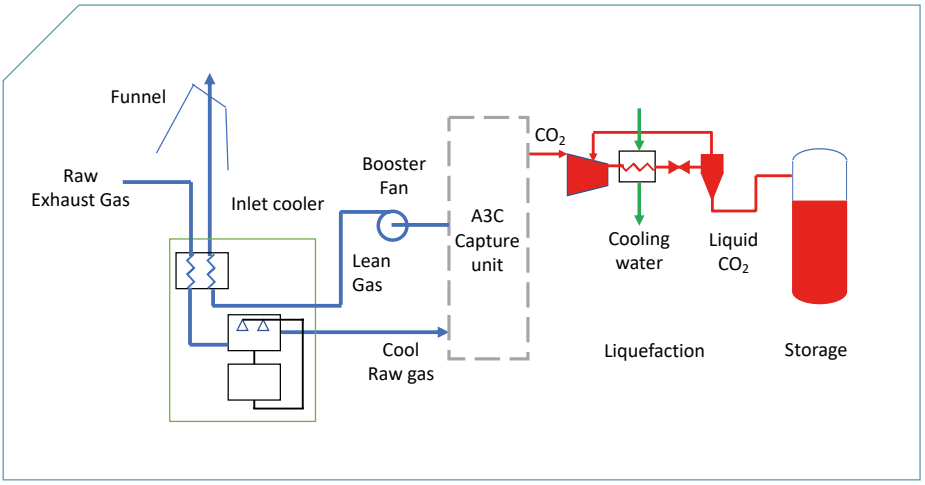
GOVERNMENT FUNDING FOR CLEAN TECH

Key to supporting the development and adoption of emerging tech is renewed interest and investment from national governments. The UK's Department for Transport launched its Transport-Technology Research Innovation Grant (T-TRIG) in 2014 to facilitate the development of cleaner technologies for transportation and commissioned a report in 2019 to explore the take-up of emissions reduction options and their impacts on emissions and costs.

As a design and engineering consultancy with expertise spanning the marine, energy and defence markets, Houlder believes it is important not to view these sectors in isolation. Particularly in facing the all-encompassing challenge of climate change, innovation and cross-pollination of industrial and technical disciplines will open doors and inspire advancements that can support both the marine and energy sectors. This will be key to unlocking the challenges ahead in managing the energy transition.

In support of this, Houlder is working in partnership with PMW Technology — awarded funding from T-TRIG — on a study to evaluate the potential marine applications of carbon capture technology. The study will evaluate the feasibility, costs, infrastructure impacts and potential benefits of using advanced carbon capture technology to decarbonise marine shipping.

Leveraging its experience in marine engineering and vessel design and specification, Houlder is consulting on key variables within the study to assess the operational viability of the technology and its potential application for shipping. Progress to date has outlined a promising pathway of development for marine carbon capture to link with existing carbon dioxide markets and developing geological storage systems.



Outline A3C implementation on ship

"Carbon capture is already proving a challenge for large onshore facilities and the size, scale, and technical challenges of current carbon capture processes have, to date, been even more difficult for the shipping industry"

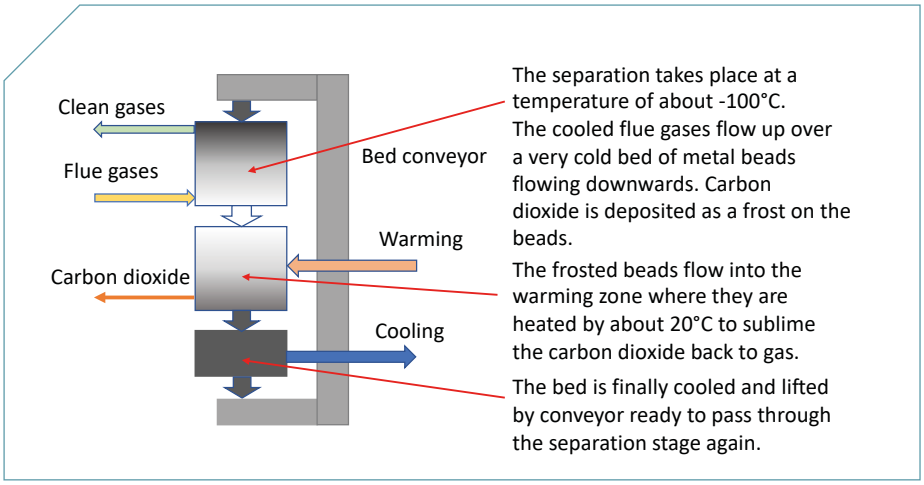
THE A3C CARBON CAPTURE INNOVATION

PMW Technology's advanced A3C carbon capture technology is built upon refrigeration and carbon storage technologies, which are already widely used and well understood across the marine and energy sectors. The system adapts itself to the shipping sector by employing a simple concept utilising the fundamentals of refrigeration technology to separate and liquefy the carbon dioxide from marine engine emissions.

The separation of the carbon dioxide from fuel combustion is facilitated by cooling the engine exhaust gases to the point that carbon dioxide freezes and deposits as a frost. In existing refrigerated carbon capture this frost clings to the cooling pipes in the separation region, degrading heat transfer and requiring complex freeze-thaw arrangements to recover CO_2 for storage.

The A3C system moves a pre-cooled packed bed of fine metal beads through the separation region, capturing the carbon as frost on the beads. The beads are then moved into a recovery region where the carbon dioxide is evaporated by heat rejected by the refrigeration system and then liquefied for storage in a conventional medium pressure tank.

The beads are once again cooled and fed back into the separation region for continuous capture. The bead temperature determines the proportion of carbon dioxide removed. More than



Core separation process

99% can be removed, but economics favour capture of 90-95%.

PMW Technology has worked with the University of Chester for almost four years, testing and developing the A3C system with great success — particularly in refining the moving pack bed innovation and its interaction with the refrigeration technology. Work is also underway to optimise the heat transfer and cooling process, and to further assess the distribution and recovery of gases from the packed bed through the separation region.

The process has already been evaluated for industrial applications, showing substantial advantages over conventional absorption processes using toxic amine solvents. With support from funding from the Department of Transport through the T-TRIG grant, the collaboration between Houlder and PMW Technology will deliver a thorough evaluation of its potential for shipping. The assessment includes case studies on different vessel sizes and fuels and takes account of the implications for bunkering and onshore carbon dioxide geological storage systems.

OBSERVATIONS TO DATE

Houlder's work in the study has identified engine load and weight distribution as key considerations in the design and operational implications for the A3C system on board a newbuild vessel.

The system requires additional electrical power to drive the refrigeration and liquefaction processes. Beyond this, safety and vessel stability — key concerns for mariners across the carbon capture debate — have been a central focus point within the modelling undertaken by Houlder's experts. While the scope of the project is largely focused on newbuilds, the feasibility of retrofit is also being investigated.

Captured carbon dioxide stored on board the vessel weighs approximately three times that of the fuel used. While this has an implication on the vessel's deadweight in the arrival condition, with appropriate positioning of the storage tanks this added weight can reduce the ballast requirement in the arrival conditions.

Meanwhile, for ro-ros, captured carbon dioxide can also be stored in ISO containers on the car deck and offloaded at each port call, limiting the implications of the system on the deadweight in the arrival conditions.

Houlder and PMW Technology envision ro-ro as the most appropriate trade for pilot testing of carbon capture, utilising this method of containerised storage and discharge at port as the core method of unloading captured carbon. The demand for containerised liquefied CO_2 for industrial purposes is already established, thereby granting the ship owner ready access to the supply chain and customers.

Removal of larger volumes of captured carbon for deep-sea trades requires further consideration. One concept to explore may be the adaptation of bunkering vessels, which could deliver the required fuel and remove the CO_2 from the vessel's storage tank, delivering it to the nearest carbon cluster before taking on its next volumes of fuel.

When it comes to safety, the system conducts mechanical rather than chemical carbon capture and is built on principles and components already well understood across the industry. This means the system can be maintained and operated by marine engineers within their existing scope of expertise. It is also safer, with no specialist engineering required for the handling or containment of hazardous chemicals.

Cost analysis and projections for the system are currently underway, in line with the scenario analysis on emissions-reducing measures for maritime conducted for the Department for Transport in 2019. Preliminary findings show that the technology fares well in comparison with zero carbon fuels such as ammonia.

Commitment to carbon capture and storage by national governments is increasing, providing opportunities for linking of marine and land-based and industrial sectors to support ship owners in covering the operational costs of the system.

The UK is actively progressing with the development of its carbon storage and transportation initiatives. The chancellor has committed to £800m investment in the initial industrial carbon capture clusters to be operational around 2030. Work is currently progressing on funded deployment planning for six clusters. Equally, the US government is offering support for carbon dioxide for enhanced oil recovery at US$35 per tonne.

Shipping's energy transition will require a multitude of carbon reduction technologies if ambitions are to be realised. With growing interest in carbon capture the world over, there is ample opportunity for the shipping sector to integrate itself within this space.

Now is the time to ensure that this, and all potentially viable options are properly explored — missing one could make the difference between success and failure.

Marine litter — in particular plastic — poses a huge threat to our oceans. What initiatives are being taken to combat the problem and clean up the world's seas?

PULLING THE PLUG ON PLASTIC

by Fazilette Khan, founder of GreenSeas Trust and an ex-seafarer

Those single-use plastic drinks bottles and food wrappings left on the beach, the unwanted light polyethylene bags left to drift in the winds, rubbish thrown in waterways and drains, industrial waste with rivers providing an important pathway to the sea — they all add up to make the estimated 12.7m tons of plastic that ends up in our oceans each year.

If that was not bad enough, the volume of marine plastic litter increases exponentially as ultraviolet light (UV) and mechanical wave forces break large pieces of plastic into smaller ones. This very slow degradation of synthetic organic polymers into smaller and smaller pieces becomes microplastics — plastic litter that is less than 5mm in diameter. While it is hard to put an exact figure on just how much plastic particles are in the oceans, studies led by the University of Manchester found seafloor sediment accumulations can control the distribution of microplastics and create hotspots of up to 1.9 million pieces/m².

Some 80% of plastic litter in the oceans is attributed to come from land, with the remaining 20% from marine sources. According to the United Nations Environment Programme (UNEP), abandoned, lost or discarded fishing gear makes up half, if not more of this figure.

Whatever the source, the consequences remain the same — the smothering of the ocean floor, strangulation of marine life and the suffocation of coral propyls, all of which have an effect on fish stocks and, higher up the food chain, our health.

It has been more than 30 years since MARPOL Annex V prohibited the discharge of plastics, including discarded fishing gear, into the sea from ships, yet the problem from these sources persists in 2020.

So what can the maritime industry and regulators do to halt the increase of marine plastics before it is too late?

In January 2018, the European Commission put forward a new legislative proposal seeking to improve the collection of ship waste while ensuring efficient maritime transport operations in ports. It was adopted by the Parliament in plenary on 13 March

Volunteers clean up rubbish and plastic debris on a dirty beach

2019 (by 596 votes in favour, 16 against and seven abstentions) Member States have two years to ensure their national law complies with the adopted rules, that is by 28 June 2021.

The new plan requires ships to pay an indirect fee, irrespective of delivery of waste. This covers all ship waste except for cargo residues and waste from scrubbers. The plan is both simple, effective and an excellent deterrent for dumping waste at sea. If there are no savings to be made, why break the law? Better to land it, than get fined for illegal disposal.

The plan is also fair one. Ships engaged in short sea shipping as well as "green ships" are entitled to reduced port fees (rules to be set up by an implementing act). The plan also requires member states to inspect at least 15% of ships calling annually at their ports. Small non-commercial ports, with low or seasonal traffic, do not have to prepare waste reception plans if their port waste collection is integrated into the municipal waste handling system.

If countries around the globe adopted this blueprint, illegal dumping of garbage into the seas could become a thing of the past.

Another important avenue to look at is the use of single-use plastics. Although applicable to most ships, the cruise industry, in particular, has to be singled out.

Cruise ships represent less than 1% of the global merchant fleet and yet are responsible for an estimated 25% of all waste generated by merchant vessels — not surprising, when you consider 28.5m people took a cruise in 2017 to 2018.

Polyethylene terephthalate (PET), used to fabricate beverage containers, especially bottled water, makes up a large part of this figure. To reverse the misconception built up over the years by the big multinationals, that bottled water is best, providing filtered water in reusable jugs, glass bottles or at cooler stations would not only alleviate the problem of these plastics, but also save much-needed space on board, which is always a premium on any passenger vessel.

Using eco-friendly alternatives to sachets, miniature toiletry bottles, plastic cutlery and the plethora of other single-use items is another way of cutting down plastic consumption. It would reduce the volume of waste generated and, in turn, the burden on port garbage reception facilities. The knock-on effect would also be seen in the land-based processing of these wastes and use of landfill.

The fishing industry is a major contributor of marine plastic. Lost, abandoned or deliberately dumped fishing gear such as nets or traps is the killing of marine life and a hazard to navigation from entanglement of propellers. While there have been new

innovative experiments from eminent universities to make fishing nets degradable, they are not biodegradable. Ultraviolet light from the sun simply degrades the polymers into microplastics, adding to the estimated 15-51tn pieces said to be in the oceans.

The International Maritime Organization (IMO) and the Food and Agriculture Organization of the United Nations (FAO) launched the GloLitter project in December 2019. The GloLitter Partnerships Project aims to help shipping and fisheries move to a low-plastics future. The project also promotes compliance with relevant voluntary FAO guidelines. This includes the marking of fishing gear and tracking it back to its owners if discarded.

Currently being reviewed are identifiers such as vessel registration details, port letters and numbers or the IMO number. It also advocates an increase in Port State inspections of these fishing boats to ensure monitoring and compliance.

While these guidelines are currently voluntary, their positive effect in the fight to reduce marine plastic pollution would be considerable if adopted, as a compulsory MEPC resolution.

However, one of the simplest yet completely overlooked solutions that maritime companies can do is to provide awareness education for ships' crews, of the impact of marine plastic litter. Companies may think anyone who makes their living by the sea should be aware of the problems associated with this global problem, but as an ex-seafarer myself I can report that this is simply not true. I was once told by a crew member when caught throwing piece of plastic overboard: "It's not my sea."

It was only when I explained that the sea does not have boundary lines, did the penny drop. He realised that discarding a plastic item in the Atlantic ocean can have consequences as a far afield as the Pacific.

Seafarers, like many people on land, don't make the connection between their own actions and the consequence this has on oceans. It may seem that throwing an innocuous cigarette butt in the sea from the deck of ship is hardly going to matter, but when looked at collectively, it adds to the four trillion cigarette butts estimated to be in our oceans, each one leaching over 200 toxic chemicals into the water.

Cigarette butt filters are made of cellulose acetate fibres (a plastic) that does not biodegrade. These fibres, each approximately 20μm in diameter are packed tightly together. They are the number one item found in coastal clean-ups. From the smallest coaster to the largest vessel, having ship's crews attend awareness classes can only benefit the seas and protect our food chain.

"One of the simplest yet completely overlooked solutions that maritime companies can do is to provide awareness education for ships' crews, of the impact of marine plastic litter"

The IMO identifies hull scrapings, marine coatings and anti-fouling systems as potential sources of microplastics to the oceans. Many modern anti-fouling paints follow a co-polymer approach. This is where a toxic metallic/biocide compound is embedded within a polymer (plastic) resin. Through interaction with water, a constant release of settlement-inhibiting organo-metals and biocide is achieved.

The report acknowledges a lack of uniformity in regulations of in-water cleaning as well as conclusive in-depth studies. This has meant there are data gaps on the presence of microplastics in the ocean, through activities such as hull cleaning, replacement of hull coatings and the normal wear of anti-fouling hull coatings.

However, the comment on it from Pagoropoulos (pers. comm., 2018) gives food for thought: "You have a couple of tonnes of epoxy on each ship that over the five years' lifecycle just wash off like soap. Where does it go? And what is the impact of it?"

Research into formulations of antifouling coatings devoid of toxicity towards marine environments are currently underway. Their aim is to create efficient paints based on biodegradable polymer and with no organic biocides. While we await this holy grail, ship and recreational boat owners can take a proactive approach when undertaking in-water cleaning by using contractors offering all waste to be collected.

If we are ever going to reverse the trend of an ever-increasing tsunami of marine plastics, the maritime and shipping industry has to play its part. Increasing crew awareness of the marine litter problem, supporting organisations with long term solutions, reducing single-use plastic consumption on board vessels and enforcing regulatory laws and fines for offenders is a good place to start.

The GreenSeas Trust's BinForGreenSeas Project visually educates the public of the marine plastics problem using a striking, nautically themed functional bin **greenseas.org**.

QUADRISE: INTRODUCING A GREENER FUEL OPTION

Quadrise is the innovator and global licensor of disruptive technology that produces a synthetic, enhanced heavy fuel oil (HFO) called MSAR®. This HFO offers operational, economic and environmental benefits compared to bunker fuel oil, reducing OPEX and environmental footprints simply, quickly and efficiently.

MSAR® blending technology is installed in refineries by Quadrise at low cost to produce MSAR® fuel, which is an enhanced emulsion fuel for use in marine, power, industrial and upstream applications.

Our proven technology blends heavy residual oils with small amounts of specialist additives and water to create a highly stable, low-viscosity emulsion containing approximately 70wt% hydrocarbon (with no cat fines), as pre-atomised micron-sized droplets, dispersed in 30% water with <1% additives. Other than water content, MSAR® fuel properties are similar to RMG ISO8217.

As no expensive distillate cutters are needed, manufacturing costs for the refinery are lower than for fuel oil, with the fuel price discount being a function of the gas oil and fuel oil differential.

Typical savings for bunker consumers, on an energy equivalent basis, are circa 10%. For illustration, a vessel consuming 16,000 tons HFO annually would save $400,000pa, assuming $250/mt HFO.

The physical characteristics of pre-atomised, <10μm fuel droplets dispersed in water result in enhanced combustion performance and a significantly reduced environmental footprint versus conventional fuel oil. MSAR® burns like gas, with high carbon burnout resulting in fewer particulates and virtually no "black soot", reducing global warming and the waste disposal impacts. The fuel's water content reduces combustion temperatures and associated NOx generation by 20-50%.

Marine MSAR® was developed in collaboration with Maersk, engine manufacturers Wärtsilä and MAN Diesel & Turbo, AkzoNobel (now Nouryon) and classification societies such as Lloyd's Register. It builds on 60m tons of emulsion fuel use, with successful ocean-going vessel trials using modern MAN and Wärtsilä main engines completed. MSAR® is fully compatible with exhaust gas scrubbing and Tier 2/3 NOx control.

Vessel modifications for fuel handling are minor, can be implemented in service and typically pay back the investment in less than a year.

MSAR® is supplied to clients on a B2B basis, ensuring known provenance and no unwanted chemicals or blendstocks such as slurry oils. MSAR® also solves blending compatibility issues (the hydrocarbon droplets do not chemically interact), so that operational problems such as incompatibility and sedimentation do not occur.

For further information:
Email: info@quadrisefuels.com
quadrisefuels.com

Shipping faces a tremendous shared challenge as it looks to rapidly decarbonise — but the current global situation offers a galvanising push to achieving the IMO's goals

ALTERNATIVE **ACTION**

by Anniek Sluis (above), Growth Captain of The GoodShipping Program, and Isabel Welten, Chief Commercial Officer of GoodFuels

In the coming years, our sector needs to dramatically accelerate its alternative fuels and technology development — with the former of these acknowledged as being the main driving force behind the radical transformation that shipping needs.

Covid-19 has recontextualised this urgent transformation and is placing it under immense stress. Some are arguing that shipping may turn back from its decarbonisation goals and focus on other priorities.

However, there is more discussion arising that says the current world health and economic situation may be the massive galvanising push that our sector needs to meet the goals laid out by the International Maritime Organization (IMO).

Shipping's decarbonisation target hinges on the development of alternative fuels. And while some of these may seem far off, there are already existing solutions on the market that can help leading owners, operators and cargo owners to meaningfully and easily improve their sustainability and reduce their environmental impact.

For the past five years, GoodFuels has focused on realising the widescale use of sustainable marine biofuel, which has enabled us to develop a carbon-busting solution that is scalable, truly sustainable, technically compliant and affordable.

We believe biofuels are a true solution to shipping's challenges, which can be used today. We work closely with feedstock owners, technology developers, research institutes and universities to bring innovations from the lab to commercial application, which enables us to develop high-quality, sustainable, scalable and affordable biofuels.

In 2018, we launched our Bio Fuel-Oil (also known as BFO or GoodFuels MR1-100), which is the first ever residual fuel-equivalent biofuel that is sustainably sourced and completely derived from sustainable waste and residue products. Importantly for the uptake of the fuel, our sustainable biofuel requires no changes to

marine engines. The biofuel "drops in" to normal fuel tanks, virtually eliminating all (80-90% well-to-propeller) carbon emissions, compared with fossil equivalents.

Alongside supporting the industry's impending decarbonisation goals and due to the absence of sulphur, BFO is also a viable alternative to both distillates and Ultra Low Sulphur Fuel Oil.

Our BFO is a marine specific product. However, clearly there is an immediate urgency to reduce the carbon footprint from transport in all segments, which is why we supply our sustainable biofuels not only to marine. We want to support all hard-to-decarbonise sectors, including road, rail and shipping.

There are a variety of ways to produce biofuels, but generally they are made by breaking down the molecules in the plant through different processes. The resulting products are then refined and can be made into different biofuels. Ours are produced from certified feedstocks that are labelled as waste or residue and they do not interfere with food production or deforestation.

As we have various biofuels in our portfolio, the production processes can vary significantly, but for all biofuels the footprint from production is included in the total carbon reduction calculation. Moreover, our production capacity differs depending on particular fuels. We are continuously working with our partners across the fuels and bunker markets to scale up refining capacity for all different biofuels, as we see demand increasing steadily.

Scaling up demand is important, because biofuel is more than a bridging fuel; we expect that marine biofuels will constitute 10-15% of the future marine fuel mix by 2030.

Our approach has been based on working with leading owners, operators and charterers to help accelerate uptake of the fuel. In March 2020, we announced that Stena Bulk had joined our list of valued first movers and we kicked off with a first test of BFO on Stena Bulk's 49,646-deadweight tonne Suezmax tanker *Stena Immortal*. She received the first delivery of "drop in" BFO during her call at the Port of Rotterdam and the fuel was used to power her main engine, with the ultimate aim of further testing the technical and operational feasibility of BFO.

The trial marks yet another important test of our BFO with a leading market player and is another crucial move towards offering the shipping industry a credible near-zero carbon alternative to fossil fuels. It reflects a level of ambition from Stena Bulk about how quickly the company wants to work towards shipping's decarbonisation goals and, once again, proves to the market that solutions already exist to help reduce the carbon impact of our operations.

Now the successful trial on *Stena Immortal* is completed, we will continue to work with Stena Bulk to gain more experience. As we are also continuing our collaborations with other partners within the tanker segment, such as Norden, we are effectively exploring options for upscaling the usage of marine biofuel, as an alternative to conventional fossil-based fuel.

As mentioned, Stena Bulk joins a group of other leading owners and operators who have been progressive leading lights as we work to scale up biofuel usage. Last year, GoodFuels announced that our BFO product was being used in a landmark trial with IKEA, CMA CGM and the GoodShipping Program.

In March 2019, we were proud to make the world's first refuelling of a container ship with marine biofuel. Under the joint trial, sustainable BFO was used in a blend with conventional fossil-based marine fuels to power one of CMA CGM's container ships on a major oceangoing route. Applications of the BFO again showed a positive result, thus proving the technical compatibility of sustainable marine biofuels.

What this reveals — and at the heart of our approach — is a mantra based on working across the maritime industry's key segments to scale up the use of biofuel. Because biofuel is "drop in", it can work with any vessel type; a fact that is becoming increasingly recognised in the maritime industry's owner/operator community. However,

owners and operators are not the only parties realising that they have important roles to play. Cargo owners and shippers are also coming under increasing scrutiny for their choices in the supply chain and are becoming keen to show consumers their environmental credentials through the use of sustainable transportation.

This is one of the reasons GoodFuels created the aforementioned GoodShipping Program three years ago, which supports shippers to commit to a reduction in their sea freight CO_2 emissions.

The initiative works on the premise that, as all CO_2 from shipping is emitted into the same atmosphere, the means of mitigating these emissions is equally impactful, regardless of which vessels adopt biofuels over traditional bunker fuels — or the amount of "drop in" biofuel that is added to the fuel tank (concept of mass-balance), as long as it offsets the CO_2 costs of transporting participating shippers' cargo.

Shippers benefit from becoming GoodShipping Program pioneers because this part of the supply chain was previously something that they did not have control over or would not have any say in. Typically, these are organisations with strong public brands and whose customers are demanding more information about how a product reaches them. This gives shippers a way to make an immediate impact and improve the sustainability of their supply chains — and support the acceleration of the energy transition within shipping.

The GoodShipping Program has already seen tremendous success and interest, and is a reflection of the increasing visibility that we all find ourselves operating under. All of this shows that the momentum for decarbonisation in shipping is reaching a critical mass, with many owners and operators deeply invested in improving their own sustainability and reaching the IMO's targets.

We must not let Covid-19 derail these efforts, but should instead use the current situation as the force we need to accelerate these changes. The work of first movers in doing so will be vital in the years to come.

Although the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships was introduced in May 2009, it is yet to be ratified. But by working together, shipping can start making ship recycling safer, cleaner and fairer from today

RECYCLING AT ITS BEST

by Yuvraj Thakur, General Manager, Verifavia Shipping – IHM

Ship recycling practices need to be brought into the 21st century. This is why the Hong Kong (HK) International Convention for the Safe and Environmentally Sound Recycling of Ships was introduced in May 2009. India's ratification in November 2019 brought entry into force a lot closer, but until another country with a large fleet follows suit, there is still a way to go.

That said, change needs to start now. Shipyard workers deserve greater protection, which requires training and robust auditing of the yards themselves. As environmental, social and governance drivers become stronger and regulations designed to accelerate future sustainability become more stringent, it is time for the shipbreaking and wider maritime industry to take action.

By working together, shipping can start making ship recycling safer, cleaner and fairer from today.

Entry into force of the HK Convention will happen 24 months after three separate criteria have been met. It must be ratified by 15 States – India was the 15th state to ratify the Convention – and these states must represent 40% of world merchant shipping by gross tonnage. This currently stands at just below 30%. In addition, a combined maximum annual ship recycling volume (during the preceding 10 years) is required of not less than 3% of their combined gross tonnage – this was 2.6% at the last count.

The Contracting States to the HK Convention are, as of end-November 2019: Belgium, Congo, Denmark, Estonia, France, Germany, Ghana, India, Japan, Malta, Netherlands, Norway, Panama, Serbia and Turkey. Between them, they represent just over 30% of the world's merchant shipping tonnage.

With the required 15 sovereign states now party to the Convention, and India's ship recycling volume contributing considerably to the required recycling capacity, its involvement brings this important convention a significant step closer to coming into force. However,

further tonnage and recycling volumes are needed before this can happen. Only once fully ratified and approved will we understand exactly how it impacts the industry. But this is not far away.

Bangladesh has reportedly been receiving international aid from Norway for the upgrading of recycling yards in Bangladesh and with two yards close to meeting the requirements and more yards in the process is approaching completion.

It is also important to note that the HK Convention has already been implemented for EU-flagged vessels and vessels from third countries calling at an EU port or anchorage through the EU Ship Recycling Regulation (EU SRR), therefore contributing to its global entry into force with the deadline for the end of this year.

With ratification not far away, it is essential for shipping companies and ship yards to recognise the importance of preparing for the enforcement and ensuring there is budget set aside from the beginning of owning a vessel to ensure there are funds available for recycling the vessel safely, efficiently and environmentally at the end of its working life.

A small monthly contribution to a "retirement fund" would go a long way in ensuring the safe recycling of the vessel when it gets old and would also protect shipping companies from unexpected expenses.

IMPACT OF RATIFICATION

Given that the regulations will affect approximately 100,000 ships, the impact will be huge. The Convention aims to address all the issues around ship recycling, including the potential for environmentally hazardous substances such as asbestos, heavy metals, hydrocarbons, ozone depleting substances and others to be onboard vessels.

It should also improve working conditions and the environmental impact of these conditions in many of the world's ship recycling facilities.

The guidelines outlined by the International Maritime Organization (IMO) highlight that, in the process of recycling vessels, virtually nothing goes to waste. Steel, for example, can be reprocessed for the construction industry and generators reused on shore.

As well as having a positive impact on the environment, it is important to recognise that responsible recycling also contributes to the global conservation of resources and — in the process — employs a large workforce, contributing to local economies.

The entire industry needs to be contributing to minimising risks and environmental issues throughout the process to form a truly green industry.

Collaboration is key. Not only do shipowners need to be responsible for the vessel during its lifetime, the shipyards also need to recognise their role in protecting their workers and the environment.

At the outset, the design and construction of vessels must be considered to facilitate safe and environmentally sound recycling, but without compromising the safety and operational efficiency of ships.

The establishment of an appropriate enforcement mechanism for ship recycling, incorporating certification and reporting requirements, will also be essential.

The industry must unite to ensure this process is as effective as possible; from protecting workers to utilising vessels materials in the most cost-effective way.

PREPARATION IS KEY

Ship recycling yards will be required to provide a "Ship Recycling Plan", specifying the manner in which each ship will be recycled, depending on its characteristics and its Inventory of Hazardous Materials (IHM). Measures need to be taken by each jurisdiction to ensure that ship recycling facilities comply with the Convention's rules.

Also, under the HK Convention, ships sent for recycling are required to carry an inventory of all hazardous materials on board. It identifies their location and approximate quantities onboard the ship.

This will help workers identify areas of dangerous materials, the quantities involved, and assist in being able to dispose of them safely; both for themselves and to prevent environmental pollution.

This process requires an initial survey to prepare the IHM, continuous maintenance during the life of the ship, and a final survey prior to recycling. Part I of the IHM is developed at the design, construction and/or operational stage of the vessel, and Part II and Part III are developed before a ship is recycled.

However, Part I of the IHM for existing ships, whose building contracts have been placed before the entry into force of the Convention, must be developed not later than five years after the entry into force of the Convention.

Zeaborn-Verifavia-Korean Register-Nautilus Log Co-operation (© Michael Suhr)

The development and maintenance of an IHM should be subject to two values: quality and independence. This will enhance the credibility of the IHM and prevent conflicts of interest between the entity (individual, company or organisation) developing or updating the IHM, and those verifying the IHM on behalf of the flag state. Progressive and professional shipowners, operators and managers are increasingly recognising the potential conflict of interest if the company taking the samples is also testing those samples in its own laboratories.

Verifavia Shipping provides IHM services as per the EU Ship Recycling Regulations (SRR) and the Hong Kong Convention across the globe, and the majority of our hazmat experts are marine engineers and ex-seafarers from India, Singapore, China, Hong Kong, Panama, Europe and Turkey. Using local surveyors ensures that any travel restrictions do not delay surveys, and — in normal circumstances — reduces the cost of travel. We also use independent laboratories to ensure accurate, reliable and impartial results.

MAKING IMPROVEMENTS

India and Turkey are two out of five countries that account for over 98% of all ship breaking by gross tonnage — both of whom have ratified the Convention. With just one more ratification from a country with a large fleet, such as Liberia or the Marshall Islands, the Convention will come into force.

Ahead of full ratification of the HK Convention, industry stakeholders must take action to raise standards. So far, the EU Commission has been dictating the terms of ship recycling yards and auditing them. But monitoring the standards will need to be consistent and without leniency to see true commitment to shipyard workers and the environment. While some shipyards in India have achieved approval from the class societies, they have still not been able to clear audits by the European Commission, which means there is huge disparity in quality that needs to be addressed.

Currently, if an IHM report is shown to a ship worker, for example, and they are asked to take appropriate precautions, there is not the required education or training in place to support them in making safe decisions. The industry stakeholders must take action now to raise standards, such as providing medical and financial support directly to workers, and suitable safety training to reduce accidents. Enforcement of the Convention should not be needed to do the right thing in making ship recycling a safer and more efficient process.

To ensure consistent monitoring of shipyards, the IMO needs to utilise representatives from various stakeholders, such as laboratories, flag states and IHM companies, to ensure independent oversight of ship recycling activities. Regular and unexpected audits will ensure that the EU's list of shipyards that are exceeding standards and demonstrating best practice is accurate and up to date.

The industry needs to unite and acknowledge the financial, societal and environmental benefits of ensuring a better standard of ship recycling. On-site checks and third-party inspections should be mandatory, utilising local experts around the world to ensure consistency and collaboration.

ANALYSING IMPORTANCE

Researchgate is an online community of over 17 million professional scientists and researchers. The group has analysed the importance of the HK Convention on Ship Recycling. The following is a snapshot of their conclusions:

The most compelling feature of the Convention is the life cycle approach adopted by it. It deals with the hazardous materials associated with the ship from cradle to grave and aims to prohibit and restrict their use by regulating design, construction, operation and maintenance of ships with respect to hazardous materials.

Maintenance of IHM during the entire lifetime of the ship is another major step taken in the direction of achieving safe and environmentally sound ship recycling.

Moreover, dual applicability of the Convention to both ships and ship recycling facilities makes it sufficiently broad and comprehensive, which would certainly be decisive in dealing the issue of ship recycling. It is the first legally binding instrument on ship recycling that provides uniform standards for the regulation of ships with respect to hazardous materials and also regulates ship recycling facilities in terms of operating and managing them for safe and environmentally sound ship recycling.

The adoption of the HK Convention certainly is a way forward to deal with health, safety and environmental concerns associated with ship recycling. It would bridge the gap between the existing legal instruments and the ship recycling practices.

The comprehensive applicability of the Convention to both ships and ship recycling facilities, the lifecycle approach and the legally binding criteria specifically designed for ship recycling industry are major features of the Convention.

POWERFUL AND DISTINCT

Such features make the Convention powerful and distinct from other legal regimes and guidelines concerning ship recycling. However, it is hard to anticipate the fate of the Convention without it coming into force, but it is definitely a significant step taken in the direction of achieving safe and environmentally sound ship recycling.

Unfortunately, the HK Convention still has several deficiencies and limitations. Exemptions to certain classes of ships, little incentive for recycling states to join the Convention and its over-dependence on procedures such as surveys and certification are some of the major flaws that weakens its effectiveness.

In conclusion, the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships is a framework under the auspices of the IMO that recognises the problems associated with ship recycling as a matter of international concern.

Although with certain flaws, it is a commendable attempt towards safe and environmentally sound ship recycling.

For more information about Verifavia Shipping, visit: verifavia-shipping.com

Change is blowing in the wind, to misquote the bard Bob Dylan. It is a feature of the latest crisis that the effects will be to reduce our reliance on fossil fuels, but to manage that change there needs to be disruptive technology to replace the oil and gas polluters

Alistair Johnson, the designer of the Tig Rig

DISRUPTIVE **INFLUENCES**

Coronavirus is expected to change society, with environmental solutions taking over from the more polluting, conventional, industrial energy production from fossil fuels.

Calls for the rebuilding of economies with sustainable energy and waste policies offer an opportunity for renewable solutions and innovative designs to be considered, not just within the land-based industry, but also in the maritime sector.

Even though, in the short term, the collapse in crude oil prices could serve as a brake on the development of new technologies, the long-term outlook will inevitably see oil prices rise again, and that is expected to make alternative energy sources more competitive again.

Notwithstanding the price of oil, wind-assisted ship propulsion (WASP) is an idea whose time has come, according to Simon Rogers, director at Windship and the designer of the triple wing design seen in the autumn issue of *CSI*. Rogers believes that the issue around the IMO2020 regulations has been all but forgotten in the turmoil around the covid-19 crisis and collapse in the price of bunkers, triggered by the failure of the oil producers' talks to agree reductions in production in early March.

"Nobody is thinking about the price of oil or bunkers anymore," explains Rogers. "The key issue right now is carbon emissions —that's what everyone wants to talk about and wind power in the marine sector is well placed to take advantage of that as it's the only power source that offers zero emissions."

Windship's triple wing design is being developed in the UK by a group of designers and maritime experts who are collaborating with a specialist yacht designer to offer sail power to the industry. Research on that project remains ongoing, with the latest details of the wind tunnel tests in February 2020 seeing improvements in the already impressive energy from the sails, with a further increase of 12% in the wind-tunnel tests, according to Rogers.

Negotiations with a number of potential partners are under way, but Rogers explains

that the company is not just looking to build a ship, it wants a partner with a mature technical division that can take care of the vessel's operational design requirements, while Windship develops the triple wing design for the new vessel.

However, Windship is merely one design among many, some as retrofits and others as holistic wind powered specialist vessels.

One such specialist ship has been developed by the Norwegian designer, Terje Lade and is a car carrier design known as Vindskip. Car carriers are generally high-sided and Lade has looked to utilise that fact using the specialist, and distinctive, shape of the vessel to offer wind-assisted power to the vessel.

The hybrid Vindskip is in a class of its own. This revolutionary design would use its hull — described by Lade, as being shaped like a symmetrical wing — and the apparent wind giving the ship a pull in the speed direction, reducing drag, and cutting fuel consumption.

The Vindskip concept consists of three main assets, where the wind power system is patented in major ship-building nations:

1. Wind power system
2. Cruise and propulsion power control
3. Weather routing module version Vindskip®

These three parts form a dynamic system giving fuel savings estimated at up to 60% compared to a reference ship — car carriers of 6,200-vehicle capacity.

As the vessel gains speed, the apparent wind flow over the hull will create pull on the vessel, while the cruise and propulsion power control keeps a constant speed on the ship, even though the wind will vary over time.

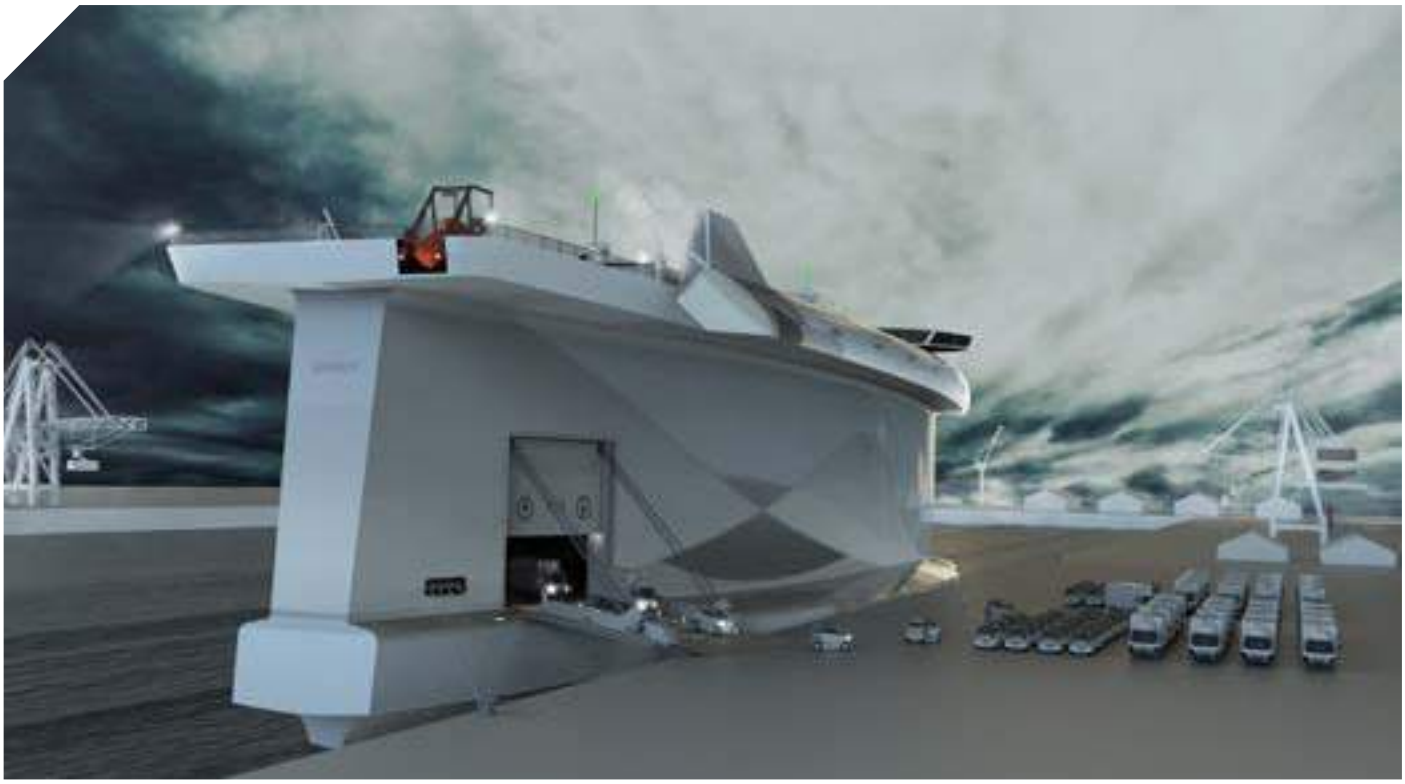
Using computational fluid dynamics, the hull design has been optimised to offer pull for the vessel from an apparent wind angle of attack of 18° through to 180° and has minimised the leeway and rudder angles to further reduce drag.

Main engine propulsion is expected to be provided by a combined system, which includes an LNG-fuelled spark ignition main engine and two auxiliary engines, one powered by liquefied natural gas (LNG) and one capable of operating on either marine diesel oil (MDO) or a biofuel. Stadt AS shaft generators and motor are fitted on the gear, with a Brunvoll Volda-designed propeller, coupled with two 910m^3 LNG fuel tanks by Høglund Marine Solution, offer a range of propulsion options.

The propulsion system would allow up to 3,000kW of electrical power from the auxiliary engines to be supplied to the propeller without the main engine engaged, offering either slow steaming and manoeuvring or propulsion assist in favourable wind conditions.

Moreover, a computer programme, developed by Fraunhofer CML, would calculate the optimum route for the vessel's journey by either prioritising economy, one with favourable winds, or the expected time of arrival to allow for greater usage of LNG. According to Lade, the dynamics for powering the vessel and its weather routing system would achieve fuel savings of up to 60%.

Lade argues that by reducing the energy demand and increasing the energy efficiency of the ship, "it is our ambition to offer the market's lowest emission for sea transport available in the deep sea car carrier segment combined with a competitive freight rate". Carbon emissions are calculated at 10.8kg per car per 1,000km, with an



Vindskip Design concept

additional 0.10kg per car to account for methane slip.

In total, Lade calculated that operating the 5,400kW engine at a 87% maximum continuous rating would consume 156g of LNG/kWh, emitting 1.25g/kWh of NOx, 0.01g/kWh of So, and 407 g/kWh of CO_2, with a further 3.8g/kWh attributable to methane slip. The methane is not negligible as LNG is calculated to be 21 times more potent as a greenhouse gas (GHG) than carbon, although it remains in the atmosphere for shorter periods. The total GHG equivalent emissions are calculated at 13.12g/kWh/car for every 1,000 miles.

By comparison, Lade said Vindskip's carbon emissions, calculated on a tonne-kilometre basis, would total 9.8g of CO_2/tkm compared with Toyota Logistics, which calculates its operations as emitting 109.6g of CO_2/tkm.

Lade admits: "The biggest cost will be the capital expenses. It is more expensive [to build] than a standard car carrier as the LNG systems are more expensive.

"Ordinary car carriers are optimised for a single speed, but these only operate at their design speed for 5% of the time, so they are not economical if they need to change to slow steaming, whereas Vindskip is economical at any speed," he concludes.

New ships and, in particular, new designs are always expensive. But to cut emissions immediately new ships are not the answer — that requires a retrofit system that can be fitted to any existing vessel, that operates in most circumstances and is reliable and easy to use.

Alistair Johnson, designer at Dasivedo, the innovators of the Tig Rig (TR) sail system, believes emissions targets from the International Maritime Organization (IMO) — 50% by 2050 — and Maersk — 100% by 2050 — are not deliverable without collaborative disruption. And, of course, that's where TR comes into its own.

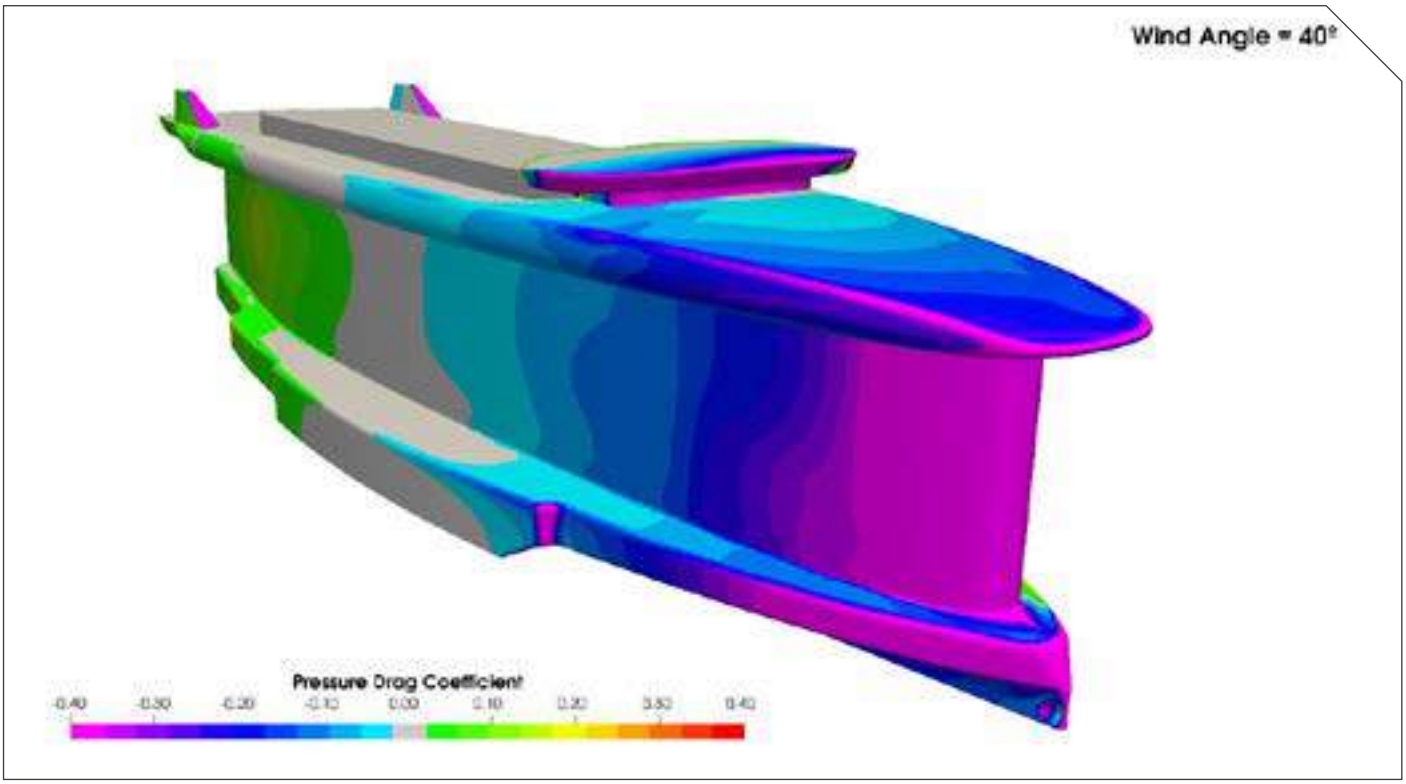
According to Johnson, the most efficient hull design currently available comes from Naviform in Vancouver. The hull design has a 40% better fuel efficiency performance compared to the average contemporary hulls, and 20% more efficient than the best contemporary hulls sea trialled in January 2020.

To equip a handymax ship with a TR system would cost around US$1.2m each; with around 40,000 flat decked ships the total outlay for the industry would be US$48bn, saving more than 4% in fleet emissions. Further savings can be realised with added solar devices.

With an international patent protected design, the Tig Rig Retrofit Sail System offers a collaboratively disruptive, Poseidon-compliant, standardised modular mounting system for all current and future masted wind-assist devices, which will help deliver the required rapid assessment and roll out of this technology.

TR aims to help the maritime industry achieve the cuts necessary to reach the IMO's target. It consists of an array of sails that can be moved on a rail around the ship and raised, lowered, and redirected to catch the wind in the most efficient manner by using electronic controls from the bridge.

The system can be retrofitted on to existing flat-decked merchant ships, tankers, and bulk carriers, as well as some ferries and container ships. It is a two-part system consisting of square-rigged sails in self-contained units that are mounted on fixed points around the hull. "The mast and sails



The pressure generated, or vacuum, shown in pink, explains the pull generated in the speed direction of the ship

can be rotated through 360° and the sails can be reefed up and down in increments of tenths of a sail drop," Johnson explains. "The mounting points are interconnected by rails that allow the units to be drawn around the ship and out of the way of dockside operations in port. A similar, but more involved, procedure allows the units to be gathered at the stern and bow for transit through canals." .

As well as controlling the sails centrally from the bridge, electronic controls at each unit can be used or, if necessary, each sail can be operated manually. "The Tig Rig units have automatic mechanical safety devices for automated reefing and automated mast release. These mechanical safety overrides prevent damage to the ship, mast, or sail through excessive wind," Johnson says.

However, he notes: "For getting through canals and clearing the units to stern and bow, the procedure is more involved. The sails have to be reefed down and the booms and sail have to be removed from the mast. This allows the cleared units to be gathered closely enough to fit at each end of the ship."

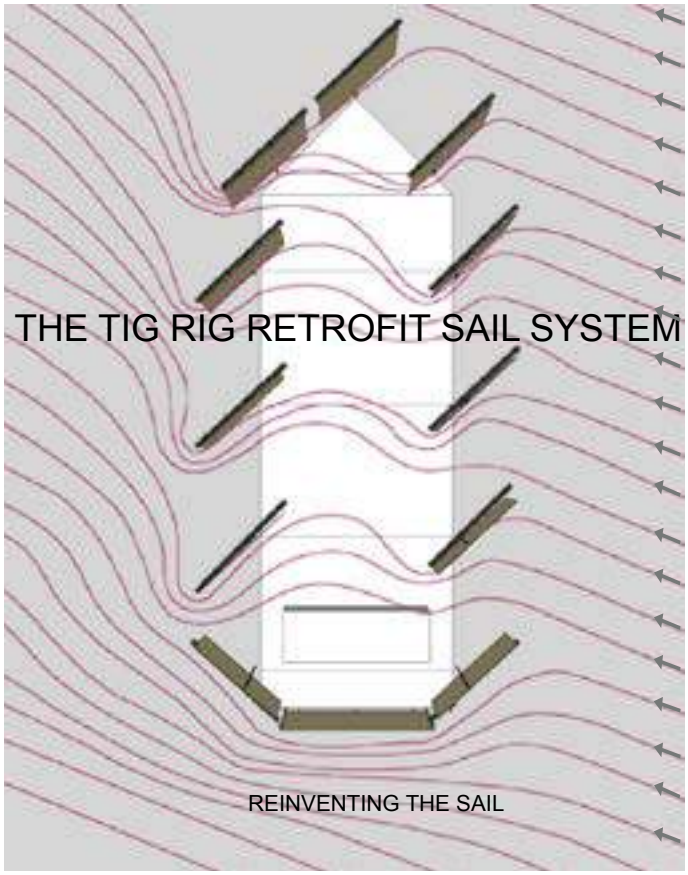
When fully deployed during testing, the sails showed significant results in fuel savings. Test data found that, for a ship travelling 12kt, thrust savings averaged 8% and increased by 3% for every knot decrease in sailing speed.

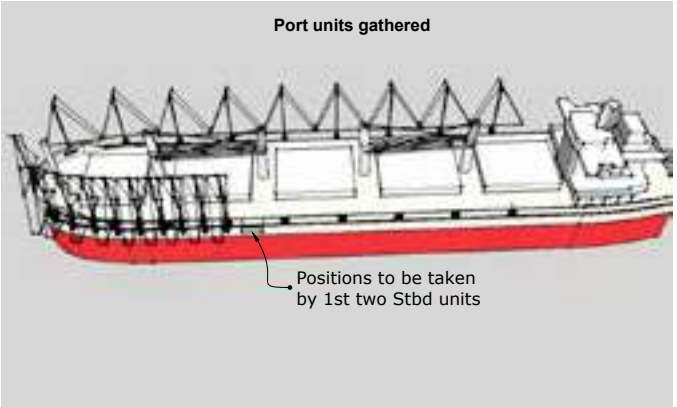
"The fixtures for TR are all above the waterline"

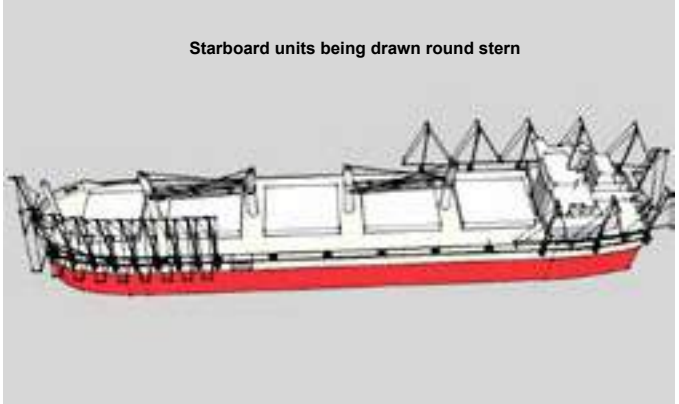
Another attractive element of the TR system is its ability to get around what Johnson calls the "split incentive" in the timecharter market through the separation of the sails with the mounting units. Owners would be particularly interested to know that as the fixtures for TR are all above the waterline, there is no need to drydock the vessel. Johnson estimates that fitting the system would take seven–10 days, depending on the vessel size.

In addition, Johnson says: "As owners do not pay for the fuel, they have no incentive to install fuel-saving devices. Because charterers have no long-term interest in the ship, they have no incentive either. With Tig Rig, the operators and charterers will be able to rent the units on a profit-share basis and be cashflow positive from day one."

It's not that yours truly wants to make a habit of misquoting poets, but in the days of the coal black, the days of crow black energy appear to be numbered, for the times they're movin' on. Energy will, in future, be supplied through the development of many fuels, it seems, and one of those will need to be the harnessing of zero carbon wind energy.







BULK TERMINALS 2020

THE ONLY EVENT AIMED AT THE ENTIRE BULK TERMINALS INDUSTRY

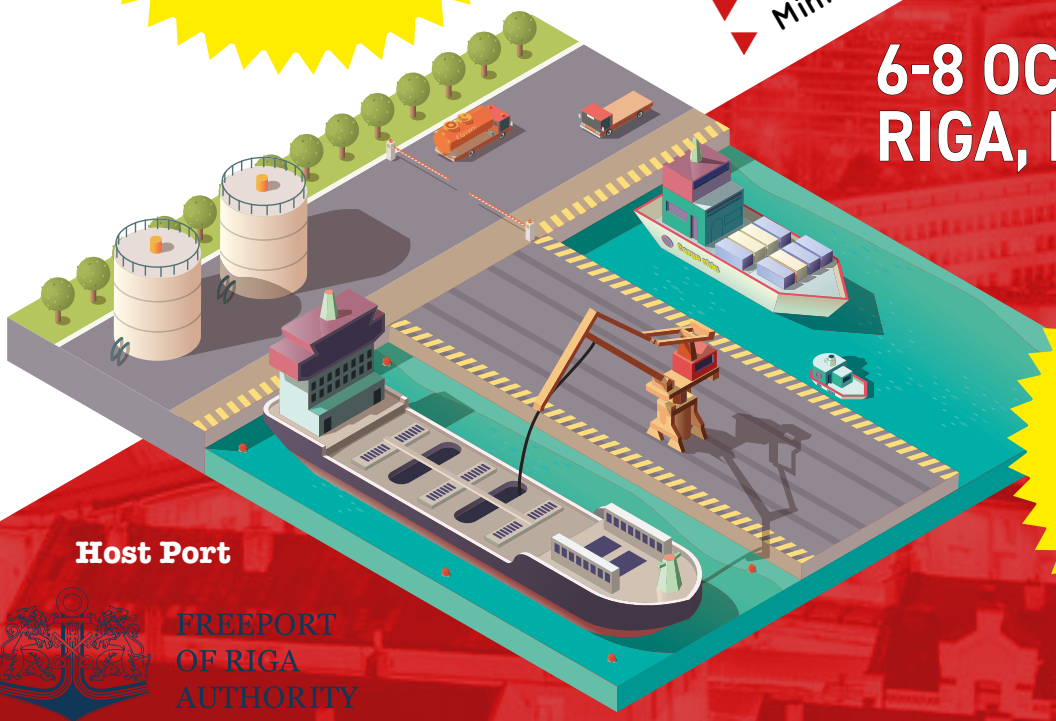
The Annual Conference of the Association of Bulk Terminal Operators (ABTO)

With sessions focused on the concerns of operators, **Bulk Terminals 2020** will consist of a **full two-day** programme on **Wednesday 7** and **Thursday 8 October.**

SESSIONS WILL COVER

- Streamlining and increasing the profitability of operations
- Development opportunities
- Impact of bulk markets on terminal throughput
- Keeping abreast of increasing environmental regulation
- Improving safety and security
- How technologies can help bulk terminals
- Autonomous operations
- Transhipment, rail and transport connectivity
- Minimising the impact of covid-19

6-8 OCTOBER 2020
RIGA, LATVIA



NEW for 2020

An afternoon terminal visit for early arrivals on Tuesday 6 October.

Host Port

FREEPORT OF RIGA AUTHORITY

Supporting Organisations

Media Partners

For more details, visit: bulkterminals.org/events.html

WHISPERING IN THE WIND

Maelstroms are rarely dull. And the coronal tornado currently swirling around the globe is no exception. In his assessment of the current, but fast developing, situation, Tristan Smith writing in this very magazine, with a story entitled Covid-19 and Shipping's Decarbonisation, argues that there are two basic forces at play, pessimism and optimism.

The pessimistic doubt that governments and firms will have the spending power coming out of Covid-19 in order to make the investments to decarbonise as needed. The more optimistic believe that Covid-19 will be a driver for investment into sustainable technology.

As dichotomies go this is a pretty good one. It offers two views neither of which allow for the view that doing nothing is a good idea, either we can't do the right thing because we don't have the cash or we will take the opportunity to change our way of life after the storm.

Storms are funny things though. They can be localised. I have my own personal lockdown storm with three teenage children with cabin fever and a dog who's ecstatic life just got richer, in the middle of pile-ons and much shouting and laughter and many walks.

There is a less the gathering corporate storm where the livelihoods of many are at stake, we have to differentiate here from the mere windbag employers who talk a good gale, but ultimately never make it out of the proverbial teacup and the major unemployment that is currently blowing through the economy.

Then there is the perfect storm where environmental sustainability meets severe economic recession and health pandemic. In such circumstances the requirement is to emerge from the crisis in a better position than we entered it. For those interested in clean shipping that must mean reducing CO2 SOx and NOx as well as other pollutants.

In this issue we look at the developments in the Hong Kong Convention for recycling ships; debris from the maritime sector that adds to the plastics in the oceans; monitoring and planning for ballast water systems; as well as the broad fuel choices and fuel efficiency systems with carbon capture and storage also being raised as a possibility now, where in the past the cost was considered too high.

The maritime industry is responding fast to the environmental requirements, whether that response is fast enough is a question that will need to be addressed in the near term. For Tristan Smith that means by 2025, though his view is that we have already passed the point where "dangerous climate change is already locked in the option is now to avoid catastrophic climate change".

That may be so, but the developments and investments in green shipping must continue. Those advances are broad and getting broader, new ideas such as the use of tourmaline for the extraction of carbon, NOx and SOx, that would be through one scrubber system. Such designs offer opportunities for both short-term and long-term adjustments for the industry, with the current fleet able to reduce its polluting potential through the retrofitting of clean technology.

If the storms are to be calmed the progress made by the industry must continue along with developments in other industries that will cut greenhouse gas emissions to more manageable levels.

One of the, perhaps, surprising consequences of the Covid-19 pandemic has been the substantial reduction in global pollution levels, which has led to a recovery of nature. Scientists and other commentators have commented on the speed with which nature has rebounded following the decline of the air pollution. It is to be hoped that the oceans will show the same powers of recovery as nature on land and in the air.

If the new horizon is green then the storms gathering in that vision must be dealt with on a global and collaborative scale, it is the only way that humanity can deal with a global problem. If there is anything to be learned from the Covid-19 outbreak it is that fact. That means regulators must step up to the plate and create the conditions that will allow the technological miracles now being wrought to be moulded into solutions that will mitigate future storms, both locally and globally. From there hope springs eternal.

PureteQ

THE SCRUBBER MAKER

We make scrubber systems for shipowners who want to save money by continuing use of HFO with scrubber while retaining a greener profile than those who use expensive compliant fuel. All scrubber systems come with state-of-the-art intuitive control systems with full remote accessibility. In times like these it is very convenient to get 24/7 remote on-line support/guidance to ship crews from our professional marine engineers. Our systems feature the lowest OPEX in the business and are easy to install. We guide the shipowner and other stakeholders through the process from order to sea-trial and approval. Once approved, PureteQ PureServ is able to quote a service agreement for any scrubber system for safeguarding MARPOL compliance as well as operational performance.

WWW.PURETEQ.COM