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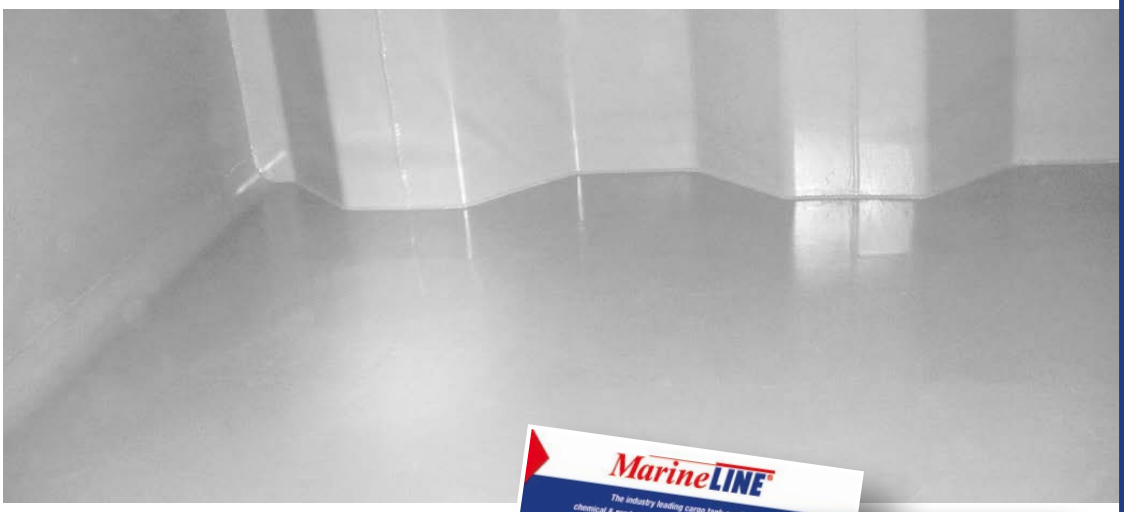

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Contents

Seafarer hassles from port authorities

Should the industry publish port corruption assessments?

I recommend you watch this 15 minute video from the Seafarers International Research Centre (SIRC) in Cardiff, released in February 2020, about the hassles seafarers are still getting in ports around the world.

https://youtu.be/JI5M2T7E4sY

Pilots demanding fine liqueurs, officials stealing chicken from freezers, deliveries of stores being blocked to ships who refuse to give bribes and cappuccino bunker deliveries.

All issues familiar to Tanker Operator readers, but seeing seafarers speak on video about their experience makes the stories much more impactful than statistics in a report.

As we hear, the worst aspect may be loss of agency seafarers suffer. Nobody likes being forced to do something which they know is wrong.

We see seafarers are squeezed between corrupt officials who give them no option but to comply with bribe requests, and shipowners who say that the company's policy is not to give bribes. So their only way out might be to pay from personal funds.

One problem, which might be described as "facilitation gift giving", has been seen by 59% of seafarers visiting Suez Canal ports. Other hotspots included South East Asia (55%), China (54%), Indian subcontinent (51%), West Africa (49%). But it had been seen by only 13% of seafarers visiting EU ports.

A majority of respondents (57%) believed the practice of demanding/giving facilitation gifts was increasing. Sometimes port officials demand cash from captains.

Whilst many companies allowed captains to distribute gifts, sometimes up to a particular value without accounting for them, they tended to have a very different approach when it came to attempts to extort cash from vessels.

69% of seafarers stated that they had experienced being on a ship when shore officials asked for cash. The most common regions where this kind of extortion occurred were West Africa (32%), South East Asia (30%), Indian subcontinent (28%), Suez Canal (22%) and China (22%).

In contrast, extortion relating to cash demands had hardly ever been experienced by seafarers calling at EU ports (3%) and had only been experienced in Turkey by 7% of respondents.

Helen Sampson, director of SIRC, says the researchers were wary of naming specific ports, because she believes the best pathway to improving the situation is to encourage individuals working in these ports, and their management, to better understand that these are not victimless crimes. Making specific accusations might provoke defensive behaviour, which would not be constructive, she says.

But here's an idea – could the maritime industry as a whole, perhaps through one of its shipowner bodies, or just the oil / tanker associations, start publishing more data, or scoring ports or entire countries, perhaps keeping it more objective and anonymised, along the lines of the World Bank Country Policy and Institutional Assessment (CPIA) index of country corruption? The objective could be to get the data taken seriously by charterers and used as part of their decision making, so they can stop shipping cargo via corrupt ports if they possibly can.

Oil companies are taking a bigger interest in human factors onboard, recognising that stress levels can have a big impact on safety. And it is easy to see how shore based corruption raises the stress level.

Is there a way that the marine departments of oil companies, who have deep maritime competence and are often staffed by ex-seafarers, could put pressure on oil company trading departments to use ports which have a lower reputation for corruption?

For example by showing that their decisions lead to seafarers being put under higher stress, which may lead to accidents, which would reflect very badly on the oil company, and the trader that made the decision to use that port?

TMSA, arguably, works in this fashion, although to help discriminate against vessels, not ports.

The marine experts in oil companies needed a tool to demonstrate that although a vessel was fully compliant with regulations, it offered very little beyond that – while another vessel was also available which offered much more, and so should be preferentially chartered.

The full SIRC report can be downloaded at

https://www.sirc.cf.ac.uk/Uploads/Publications/The%20relationships%20between%20seafarers%20and%20shore-side%20personnel.pdf

Karl Jeffery, editor, Tanker Operator

TO

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Future Energy Publishing Ltd
39-41 North Road
London N7 9DP
www.tankeroperator.com

PUBLISHER / EDITOR / EVENTS
Karl Jeffery
Tel: +44 (0)20 8150 5292
jeffery@tankeroperator.com

ADVERTISING SALES
David Jeffries
Only Media Ltd
Tel: +44 (0)208 150 5293
djeffries@tankeroperator.com

PRODUCTION
Very Vermilion Ltd.
Tel: +44 (0)1253 812297
info@veryvermilion.co.uk

SUBSCRIPTION
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Tel: +44 (0)20 8150 5292
sub@tankeroperator.com

Cyprus – education, digital, IMO and flag

We spoke with Natasa Pilides, the Shipping Deputy Minister of the Republic of Cyprus, about how the Cyprus government is supporting maritime education and skill development, how it is developing digital tools, how it seeks to influence the IMO, and is developing its flag registry

In terms of maritime education for seafarers, Cyprus has opened three maritime academies over the past few years, which are now training about 300 students on a variety of courses, says Natasa Pilides, Shipping Deputy Minister of the Republic of Cyprus.

Before that, the only possibility for maritime training for Cypriots was to go abroad, she says.

The academies are running under the supervision of the Cyprus Shipping Deputy Ministry, which monitors the schools and authorises the courses. The course content meets STCW standards and additional requirements from the Cyprus legislation.

[Note – there is no senior minister of shipping, Ms Pilides reports to the President of Cyprus. It is called a 'Deputy Ministry' due to a limit of 11 ministries Cyprus may have, under its constitution].

The places are available to students from any country and grants are available to all EU students, and there are many students from other EU countries in the maritime academies, although Cyprus offers some funded places for its own students.

The academies work closely together with shipping companies in Cyprus, to ensure the course content is relevant to current needs. Some companies offer their own scholarships and cadetship opportunities, which can turn into employment opportunities. So there is a good collaboration with the private sector, she says.

"We're trying to ensure the employment rates and retention rates [for students] are high – and we've got some very good results," she says.

Ms Pilides is keen that seafaring can lead to long term maritime careers. "You can be a seafarer for as long as you want, then there's always a job opportunity on shore. In Cyprus,

Natasa Pilides, Shipping Deputy Minister of the Republic of Cyprus

there's a lot of opportunity for experienced seafarers to work in different shipping companies."

Shipping companies in Cyprus are usually "very conscious about creating not just long term relationships and investing in seafarers – but also providing opportunity in terms of training, soft skills, response to risk," she said. There is a lot more consideration being given to such matters now compared to 20 years ago.

"A lot of effort goes into the retention and professional development of seafarers and office staff."

Ms Pilides does not envisage that Cyprus ship managers would ever have a majority of their shipboard staff actually being Cypriot or trained in Cyprus, since Cyprus is still a very small country (the Philippines is 90 x larger by population).

The objectives are more about having a pipeline where people from Cyprus can move through the roles, being seafarers, superintendents, up to senior management roles.

And of course Cyprus would always like to be a place which welcomes maritime workers from around the world.

The maritime education also extends to schoolchildren. There are outreach projects for schools, to show children what maritime careers look like, which might encourage them to take a course.

To reach even younger children, there is a program "Adopt a Ship", developed in collaboration with Cyprus Shipping Chamber and CYMEPA. A class in elementary (primary) school "adopt" a ship by sending e-mails to the crew, asking questions and sending drawings of how they picture life on a ship. "That creates more awareness about life at sea," she says.

There is a new Cyprus Marine and Maritime Institute (CMMI), which had Eur 15m funding under the EU Horizon 2020 project, and match funding from the Cyprus government. It is run in partnership with the University of Southampton, UK and the Maritime Institute of Ireland, among others. It is described as an "independent, international, scientific and business Centre of Excellence for Marine and Maritime activities."

As part of its Integrated Maritime Plan, the Shipping Deputy Ministry is running an EU-funded research project on "Marine Spatial Planning", exploring better ways to organise the use of the ocean space for activities such as fisheries, aquaculture, shipping, tourism, and renewable energy production.

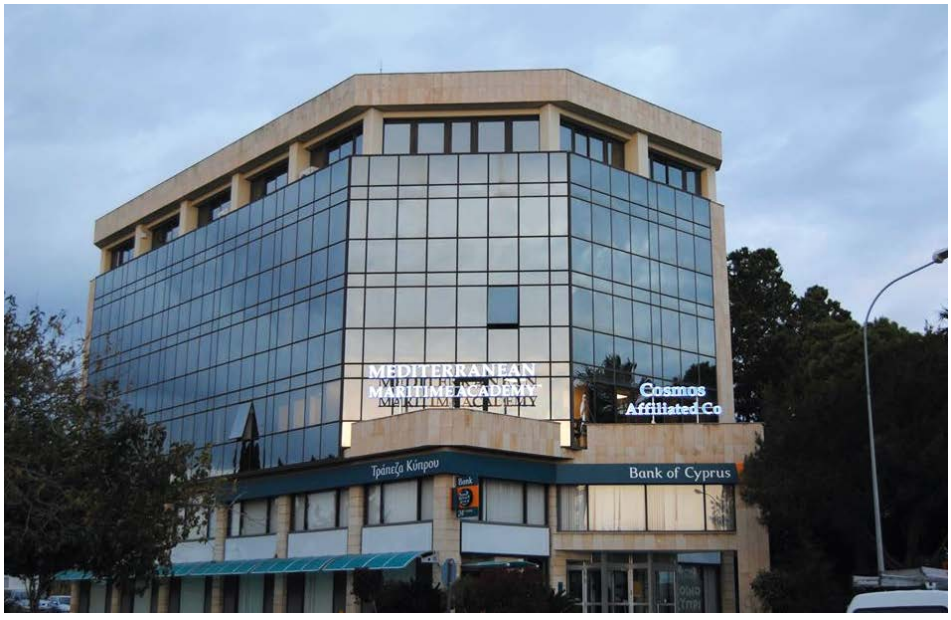
Digital

Cyprus is making big steps in the digital sector.

It has revamped its website, where a range of online services is available. There is an "e-seafarer management system", which also includes a platform where cadet seafarers share information about themselves with potential employers. The website includes an online tax submission system, tax calculators, online certificate verification and some other services.

The Shipping Deputy Ministry is endorsing the work of a private company called "Prevention at Sea" which is developing an online system for conducting port state control activities. The Fleet Information SHaring (F.I.SH.) platform, is an online ship data repository designed to standardise, automate and reduce the time spent in the ship inspection process and to facilitate ship data collection for review by third parties.

"We've been making a lot of effort to modernise the way we work" she says.



IMO and EU

Ms Pilides would like to see IMO initiate the further development of IMO GISIS to include also sections to be used by shipping companies in a format of a standard reporting scheme for communications between shipping companies and authorities, similar in philosophy with the European Union's "European Maritime Single Window" for issues related with IMO functions .

The IMO could also further improve systems for accident investigation and statistics management, such as the systems EMSA has introduced on a European level, she says.

But while it has influence in IMO and EU as a nation state, Cyprus is also small enough to have close relationships and understanding with the maritime industry. "At a local level – there is that ease in collaboration," she says.

Meanwhile in Brussels, the maritime industry has "a lot more exposure than a few years ago," she says. It can benefit from a national authority which has a good understanding of the industry.

"There's definitely a challenge in terms of what the world expects from the shipping industry," she says.

"It is also an opportunity for us to create regulations which take into account the nature of shipping and the way it works, rather than a set of rules which have to be retrofitted to the industry," she says.

Cyprus flag

Ms Pilides is keen to increase the number of vessels flagged in Cyprus. There has been steady growth over the past 5 years. The fleet is currently 11th largest in the world, and Ms Pilides would like to see it in the top ten.

To encourage ship registrations, Cyprus scrapped registration fees and mortgage fees for seagoing vessels. It is also updating the Tonnage Tax System and extending it for another 10 years, rationalising merchant shipping fees and taxes, and promoting the registry heavily, she says.

Remember time limits on demurrage claims

A court hearing in London in December 2019 reviewed the 90 day time bar on demurrage claims. ***By Nick Froude, director, C Dem Finance Ltd***

It is notorious that voyage charterparties bar demurrage claims unless presented, with the necessary documents, within a set time after completion of discharge.

This is to allow issues to be investigated before recollections fade and the trail goes cold.

Disputes are generally about whether the claim is covered by the barring clause, or what documents must be produced.

The case "AMALIE ESSBERGER" Tankreederei GmbH & Co KG v Marubeni Corporation([2019] EWHC 3402 (Comm)) tackled a number of issues on the second of these topics, in England and Wales High Court (Commercial Court), Dec 11, 2019.

The key topic was the clause as follows:

"Any claim for demurrage … [is] waived unless received ... in writing with all supporting … documents, within 90 days after completion of discharge.

Demurrage … must be submitted in a single claim at that time, and the claim must be supported by the following documents:

A. Vessel and/or terminal time logs
B. Notices of Readiness
C. Pumping Logs
D. Letters of Protest."

A requirement for "[all} supporting documents", or similar, is almost standard, and it is increasingly common to list certain documents as necessary.

Facts

Seeking about $155,000, on 22 December 2017, owners emailed their "demurrage invoice together with ... laytime calculation and support documents".

They asked charterers to "immediately advise if any ... missing in order for [them] to review [the] claim".

Charterers later said the claim was time-barred because two of A-D above had not been sent with it.

The judge called these "the Disputed Documents".

Part of C and all of D was missing, but owners had already sent that material, on 1 December.

Issues and decision

Having noted the courts' emphasis on clarity and certainty, rather than undue strictness and technicality, the judge first discussed (but did not decide) the meaning of the commonplace "all supporting ... documents."

He favoured an approach that required owners "to submit documents [that they relied on] in support of their ... claim or … [to submit] documents which taken at face value [established] the validity of the … claim".

This would allow owners easily to identify and provide the documents on which they relied, or which objectively established the validity of their claim.

It would also allow charterers to assess the claim's apparent validity or investigate the circumstances and formulate any defence.

Listed documents

Whether or not "supporting", as discussed above, and even if actually irrelevant, any documents listed as necessary had to be provided.

Did all have to be presented in one go, and what if charterers already had some of the required documents?

Charterers had argued that:

The wording required one single, simultaneous submission of the demurrage claim and supporting documents.

There could be slight flexibility, if perhaps something initially omitted was provided immediately afterwards, but the Disputed Documents had been sent three weeks before the demurrage claim.

All must come as a package, and charterers should not have to check for anything that they might already have.

But the judge rejected that, ruling first that the clause did not require the supporting documents to be provided (a) at one time and (b) at the same time as the demurrage claim.

The need to send that "with" (and likewise, we consider, if the clause had said "together with") all supporting documents just meant that all had to be sent before the deadline.

Nick Froude, director, C Dem Finance Ltd

A "single claim" meant that only one demurrage claim could be submitted i.e. separate such claims were not allowed.

As to the Disputed Documents having been provided three weeks before, what mattered was that, by the deadline, "charterers [should] have … both the claim and the supporting documentation [and] must be in a position to know that the one relates to the other [and such that] it must objectively speaking be apparent that the documentation is that which supports the claim".

Here, the Disputed Documents were among those identified as necessary (as charterers would have known), and when the claim was later sent it should have been obvious that they already had them, so owners did not have to highlight any of that.

Discussion

This decision applies, rather than develops, the law in this area, and concerns only the specific clause.

However, amid some detectable indulgence towards owners, it shows that:

Substance is preferred to form, and purely technical points will usually fail

Listed necessary documents must always be provided

The core is probably whether charterers receive in time "documents which objectively [they] would or could have appreciated [substantiate] each and every part of the claim"

Owners should where possible avoid sending their claim in several communications - the more that are used, probably the greater the risk of an issue arising

Owners might well succeed based on charterers' prior receipt of relevant materials, in some way, but they should never rely on that.

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MAN ES – a new data collaboration platform for all types of connected equipment

MAN Energy Solutions has launched a platform "mýa" to enable integration of live data streams from sensors on engines, turbines and any connected equipment, which will be spun out in an independent company.

MAN Energy Solutions (MAN ES) has launched a digital platform "mýa", to share, integrate and distribute streaming data originating from sensors on equipment such as engines. The mýa platform will form the offering of an independent company, with other companies, including competitors, invited to join and share ownership.

The purpose of mýa is to act as a broker of live data, a data collaboration platform, facilitating the integration of data streams from different sources, regardless of the manufacturer of the equipment, enabling a view of the total ecosystem with inter-relationships and dependencies.

In one example, equipment associated with engines can include pumps, fluid monitors, generators, compressors, turbines and emission controls.

Sensor data comes with a time stamp, time series data,(the time the data reading was taken.) Sensors on different pieces of equipment might record data at different intervals and quantities, but are typically time stamped. mýa can align all the time stamps, so you know what all the sensors were recording at a single point in time. This is essential if you want to analyse the data together and look at a complete view of the combined system.

Mýa does not store any of the data, only meta data (such as the volume of data handled). All data is owned by the asset owner unless agreed otherwise, and any data collaboration is controlled via contacts and agreements.

In this way, mýa could be seen as a plumbing system for data from different systems and different partners.

Right now, if a shipping company wants to work with sensor data from equipment from different manufacturers, it is really difficult. This could be analogous to the hassle of having to go to a street stand pipe to collect your drinking water in the 1800s. mýa is the equivalent of making drinking water available to you on demand through a tap, together with gas, which can be combined to make hot water, in your house, provided with a standard fitting you can easily connect your boiler to.

From its own products

The initiative of mýa, originated in the digital department of MAN ES, which was building "tools" to monitor and maintain the performance of products such as large engines and turbines in operation in the field, and recognised the need for data collaboration and standardisation, across industries such as marine, power plant and oil and gas refinery applications, where its products operate today.

MAN ES has its own asset performance platform, MAN CEON, which powers MAN PrimeServ Assist, a solution to optimize operational performance of equipment in service.

This means that the investment MAN made into developing a parallel platform for its own purposes, is now being made available to others.

Today if you use MAN´s PrimeServ Assist you are actually using the mýa service, which is operating in the background.

Inviting others

MAN ES is inviting other manufacturers, including competitors, to take ownership and join the board of mýa. It is ultimately seeking to have 5 to 10 owners, and thousands of members OEMs and asset owners alike, from all types of industry, not just engine or turbine related. "The aim is to give the control totally to the non-profitmaking organisation," says Dr Alan Atkins, CEO of mýa Connection GmbH.

Companies who are competitors to MAN ES might say, "We would like to join but we would also like to have a say in what's being done." Be being one of the founders, this is absolutely possible and encouraged.

Discussions are ongoing with major equipment manufacturers who work closely with MAN, and also with competitors.

Dr Alan Atkins, CEO of mýa Connection GmbH.

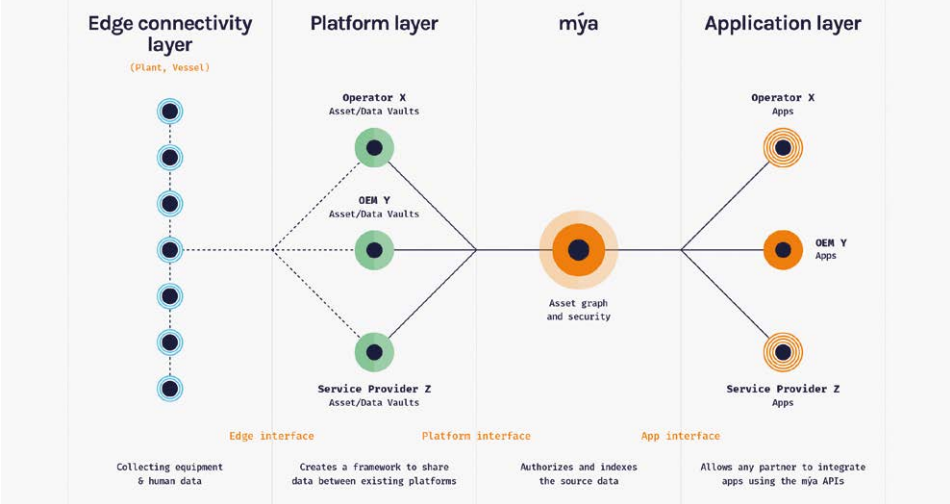
The costs of running the platform will be shared by the founders – but Dr Atkins emphasises that these are not so high – the organisation will only develop the basic functionalities. It will just administer the service and ensure uptime and security. "Applications" and analytics, will be developed where required by the members and third parties as required.

If companies decided they did not want to stop working with mýa at any time, they would not lose access to any data streams, just the integration service which mýa provides.

MAN ES has formed a new company, mýa Connection GmbH, as the vehicle to move forward, with the intention to form a separate independent non-profit making organisation during 2020.

Setting up mýa as a legal entity proved quite complex, including managing some anti-trust issues involved with having competitors working together. But now, "it is open to everybody," he said. "Including MAN ES' biggest competitors, in fact I would welcome that."

Dr Alan Atkins, CEO of mýa Connection GmbH and mýa Foundation, has a long career working in the "machine to machine" sector, including a role as global head of M2M/IoT with consulting giant CGI, then VP and global head



of IOT with Wipro, one of the world´s biggest IT and services companies.

"We already have a platform"

One of the common reactions when asked about joining mýa, Dr Atkins says, is equipment companies (OEMs) saying they "already have a platform."

But for most equipment companies, their "platform" is simply a means for them to handle their equipment sensor data to a cloud system where they monitor and predict performance of that specific piece of equipment, he says.

mýa can add value to this by integrating their existing cloud hosted data with data from other equipment companies, to be able to look at the total system view. So it is not in competition with other proprietary platforms, but a supplement and an enabler.

One login

In the short term, the biggest benefit might be that shipping superintendents for example, only need to log in once online to see data from all their equipment from multiple manufacturers, integrated together.

"One of the ship fleet owners has said, I'm so fed up of 20 different reports from different pieces of equipment and not being able to compare the data in one go to obtain a system view," Dr Atkins says.

"When I talk to technical services within OEM organisations, offering after sales services to clients, they say this is great, this is what clients really want. A way to communicate between different platforms without being locked into a commercial third party´s offering."

With this integrated view, you can monitor all the alarms across all of your assets – the status of different engines, running speed, exhaust gases, your pump performance, scrubber performance, and other data you might want to monitor.

When viewing the assets within mýa, you are able to switch views to the OEM´s own asset view and access their applications and graphical representations without having to login again. You don't need to manage lots of different passwords. Authentication has already been carried in the various OEM systems. This provides the user with a single pane of glass.

Some shipping companies are already encouraging their suppliers to make data available through the system because it makes their life easier, Dr Atkins says.

Equipment as a system

Building on this, one of the biggest areas for potential value from mýa is in how it enables shipping companies, for example, to look at their equipment as a system, rather than as a collection of individual components.

There are many dependencies between equipment. For example, a slowing down pump will mean a reduced flow rate in a pipeline, which will have an impact on whatever is downstream. A gradual loss of performance somewhere can have an impact somewhere else.

Also, if you might want to monitor the performance of a whole system. On a ship, for example, you might want to monitor the entire

propulsion system, which includes the torque on the shaft, the speed through water, as well as sensor readings from the engine itself.

The platform was designed to integrate the various data streams, enabling people to do analytics at a "higher" level. It also allows a view across multiple "systems" such as a fleet of ships or power plants.

Analytics and apps

The platform can form a basis for analytics. Shipping companies, suppliers and other software companies can build tools to generate useful insights from the data.

Data is still owned and controlled by shipping companies, power generator etc, as the asset owner, but they can see it is in their interest to allow access to it by other companies.

For example, apps could be built enabling shipping companies to monitor vessel performance, and support decision making about the best time to do maintenance or replace components, or get early warning about emerging problems, with alerts.

The app could incorporate other data, such as vessel position (from AIS) or weather data. This way, you can get more 'context' to the equipment sensor data – such as showing that the engine was working harder because there were high waves.

mýa works with about 80 standard open APIs, and can provide API keys, so it is possible for a third party software company to be able to integrate with the data given the necessary permission by the data owner, the asset owner.

The service itself could help drive more use of data standards and standard KPIs across the industry.

Supplier engagement

The platform can provide ways for suppliers to become more engaged with their customers during the product lifecycle.

Suppliers can monitor the performance of their products in use, and use their enhanced knowledge of how their products operate, to give customers advice.

They can also monitor the performance of their installed base of products across multiple customers, to better understand, for example, how their equipment wears and where improvements in design could be made.

The data can support selling spare parts and other "aftermarket" services at the right time, generating increase availability and up-time.

Satcoms and telecoms

Technical advancements in the availability of higher bandwidths with cost effective data plans, is enabling better control and efficiencies of remote assets and in turn, lower emissions.

Data communications from ships can be made over a satellite communications link, or perhaps mobile data when close to the shore.

Better and cheaper satellite communications make it possible to have live time series data from equipment, rather than just uploading data when a vessel enters port.

Investments by the Telecommunication and satellite providers have been key to enable communication with remote assets and enabling real time control and monitoring. Although seen sometimes as just a communication pipe, availability, quality of service and security is all part of a complex offering.

"We must remember that machine to machine communications have been around for over 50 years – with one of the first examples being a fax machine which could automatically say it is running out of ink," Dr Atkins says. "We are just moving on in the world of remote control and monitoring which we all hope will lead to better efficiencies, reduced emissions and standardisation providing economies of scale."

www.myafoundation.io.

LNG for a VLCC delivers "strong ROI"

A study found that running a VLCC on LNG fuel offered a better ROI than low sulphur fuel oil, but not as good a ROI as a scrubber

SEA\LNG, a trade association to promote LNG for marine fuel, has commissioned a study to see how the costs of having a VLCC running on LNG fuel would compare with using very low sulphur fuel oil (VLSFO) and scrubbers with heavy fuel oil. The study was conducted independently by simulation and analytics specialist Opsiana.

The LNG fuelled VLCC modelled was a 300,000 DWT vessel running on a trade route Arabian Gulf to China, with high pressure and low pressure 2 stroke engines.

It follows similar studies commissioned by SEA\LNG for a 14,000 TEU container vessel on Asia-US liner route, a 8,000 CEU car and truck carrier on the Pacific and 6,500 CEU car and truck carrier on Atlantic trade lanes. Background information and maritime expertise for the studies was provided by SEA\LNG members.

The results for the VLCC study were clear that "LNG as a marine fuel delivers a strong return on investment on a net present value (NPV) basis over a conservative 10-year horizon", with "paybacks from three to five years."

The study found that LNG provided a better return on investment than conventional "compliant fuels" – although an open loop scrubber actually proved a better investment.

But to achieve these better returns from scrubbers, "shipowners would take on several risks surrounding HSFO future availability, pricing savings, future regulatory restrictions, and additional potential technical performance plus operational responsibilities," SEA\LNG said.

Using LNG fuel with dual fuel engines would achieve a net present value saving of between $6.1m and $15.1m, compared to VLSFO.

LNG would be worse than scrubbers by $6.4m to $12.7m. Although a $40 per tonne CO2 charge would improve this by $4.4m.

Scrubbers were analysed in two scenarios, business as usual (BAU), and "stranded fuel". The stranded fuel scenario is on the basis that the price of heavy fuel oil would be substantially discounted (as customers move away from it) to drain down existing stocks. In this scenario, after heavy fuel stocks were drained down, it would be delivered specifically to certain customers, rather than holding supplies in port.

In terms of capital expenditure, the researchers noted that the high capital expenditure of LNG engines and fuel tanks (compared to conventional vessels) has been a barrier to adoption. But this "LNG premium" is reducing, according to recent prices offered by shipyards, as they gather LNG newbuilding experience and the technology improves.

LNG engine manufacturing has been moving towards low pressure dual fuel technology, further reducing the capex, SEA\LNG said.

In terms of energy costs, researchers noted that while energy is usually priced per ton, LNG holds more energy by mass – 2,000 tons of LNG contains the same amount of energy was 2,436 tonnes of heavy fuel oil.

The investment return calculation did not consider "branding value" gained from using LNG fuel. It did not consider any savings due to lower CO2 emissions, enabling the operator to avoid a possible future requirement to buy emission credits.

There are further possible benefits from LNG fuel if oil company charterers prefer an LNG fuelled vessel over a conventional one, on the basis that it helps them reduce their own CO2 emissions. Another possible benefit is that LNG fuel provides a pathway to using bio or synthetic methane in future, perhaps in a blend with conventional LNG, SEA\LNG says.

You can download the report here **https://sea-lng.org/wp-content/uploads/2019/12/SEALNGStudyVLCC4_compressed.pdf**

Jotun – hull cleaning service with a robot

Coatings company Jotun has launched a hull cleaning service with a robot cleaning device which stays permanently attached to the hull, activated and controlled by staff in a centre in Norway

Coatings company Jotun has launched "HullSkater", a service based around an underwater robot which can clean ships hulls of bacteria and biofilm, running across the hull on magnetic wheels.

Shipping companies don't just buy or lease the robot, they pay for a full fouling management service. The robot stays permanently attached to a vessel's hull, but is controlled by a team working remotely in Norway.

The remote staff estimate when the fouling needs to be removed, based on data about the ship's position and cross referencing it to water temperature data and other environmental factors.

When the robot is in operation, the operator can see a high resolution video feed, and understand how much fouling is actually present from this. Over time the company will be able to optimise the decision about when exactly the robot should be brought into operation.

They can also use the video feed to drive the robot.

"It is a great challenge to navigate on these huge hulls without getting lost," said Arne Rinnan, EVP sensors and robotics with Kongsberg, a partner in the project.

"We do that with sensors and technology like machine learning."

The robot is powered by batteries, driving electric motors.

The robot has a special motorised brush which can remove fouling without causing erosion or damage to the hull coating.

The idea is that if individual bacteria and biofilm can be removed early, it will stop "macrofouling" taking hold, and a requirement for reactive cleaning. This also means that there is no requirement to capture the fouling, because it is removed at an early stage before it gets thick enough to be a biosecurity risk (from depositing live microbes into the water in a different place from where they originated).

Jotun says it has been developing the technology over a number of years, with comprehensive testing on a number of vessels and ports.

Pilot projects have been running with Wallenius Wilhelmsen, Berge Bulk and Maersk.

DNV GL is also involved, providing risk management and specialist knowledge about vessel types and systems.

Kongsberg, a Norwegian technology company which has been working with underwater technology and autonomous underwater vehicles for 70 years, provided technology development, robotics industrialisation, manufacturing, services and support.

Swedish technology company Semcon is involved, providing design, analysis, software and hardware development.

Solution not a product

Jotun emphasises that HullSkater should be seen as part of a full fouling management solution for shipowners, not (for example) as just the lease of a product.

This solution includes condition monitoring, inspection, cleaning, technical service, specific level of performance, alerts and service level guarantees.

It has designed a new coating specifically for use with Hull Skater, called SeaQuantum Skate. Although Hull Skater can work with any coating, HullSkater has been optimized for proactive cleaning on SeaQuantum Skate and SeaQuantum Skate has been optimized for proactive cleaning with the Hull Skater.

The research work into the system started in 2011, when the company decided it want to move to "thinking hull performance" not thinking about fouling and paint.

Jotun wanted to create a solution which "wouldn't just deal with the problem, but rather prevent it."

"Vessels are often faced with unpredictable operations, with erratic idling periods and varied operational profiles that make the selection of antifouling problematic, even for the best coatings," Jotun said.

CO2 benefit

Jotun sees Hull Skater as a way for the shipping industry to improve its CO2 performance, as well as just reduce fuel cost.

If Hull Skater was fitted to all ships in the world, the annual CO2 savings could be 40m tonnes, equivalent to Norway's entire CO2 emission, estimates Per Marius Berrefjord, SVP strategy and business development DNV GL.

Morten Fon, president & CEO, Jotun (left) with Geir Haaoy, President & CEO, Kongsberg (right), with HullSkater

At DNV GL, "we are very serious in supporting any mission that can contribute to that."

Shipping needs to reduce its greenhouse gas emissions "2-3 times faster than what has been the normal way of going," he says.

Wallenius Wilhelmsen

Geir Fagerheim, SVP marine operations with Wallenius Wilhelmsen, a shipping company specialising in cars, trucks, rolling equipment and breakbulk, says the company has an ambition of zero CO2 operations, and this strategy could help towards that goal.

Wallenius Wilhelmsen was sceptical when it first heard of the solution, since it was coming from a company "mainly known for selling paint," he said.

But now the system has been in operation on its ro-ro vessel Talisman working around the globe for two years.

"We can see this as a potential game changer in the way we manage biofouling today," he said.

"It is a self-sufficient, semi-autonomous solution - not needing interference from the office."

TO

Hempel: coatings which reduce both corrosion and fouling

Marine coatings company Hempel has developed a new hull coating solution Hempaguard MaX which can reduce both steel corrosion and fouling, needing three coats compared to the usual five. ***By Davide Ippolito, Head of Marine Group Product Management, Hempel A/S***

Protecting the hull of a tanker requires more than a fouling-defence coating. The underlying steel itself must also be protected against corrosion.

Hempel's newly released hull solution, Hempaguard MaX, comprises three complementary products to achieve this.

The base coat is Hempaprime Immerse 900 which is applied directly to the steel. This guards against corrosion and also helps create the ultra-smooth finish that enhances the out of dock fuel savings.

Nexus II is used as the intermediary or tie coat with anticorrosive capabilities.

The fouling-defence top coat is Hempaguard X8 that drives the antifouling performance.

Together, this solution is guaranteed to deliver a 1.2 per cent maximum speed loss over a five-year period and eight per cent out of dock fuel savings when compared with traditional antifoulings.

Speed loss occurs when fouling accumulation, over time, increases drag and cause the speed of the ship to reduce even if the main engine power output remains constant.

Hempaguard MaX is fully effective in all water temperatures and conditions and continues to repel fouling when the ship is lying idle for up to 120 days. This makes it particularly suitable for all types of crude and product tankers.

Almost all hull solutions are applied in five coats. Hempaguard MaX needs only three coats. This saves the owner time and money in dry dock and application costs. It also reduces the off-hire period.

Return on investment then becomes an important consideration.

The fuel savings generated from a VLCC by using Hempaguard MaX will pay back the initial outlay in just three months. This is based on the ship operating at 70 per cent activity and burning low sulphur fuel costing 35 per cent more than HFO over a five-year period.

In these circumstances, Hempaguard MaX will deliver an annual fuel saving of around USD 1.8 million compared with the market average antifouling to deliver an ROI in around three months.

Background to fouling

Over time, all vessels attract a build up of marine organisms on the submerged part of their hull. This causes additional friction between the hull and seawater as the ship moves through the water.

As a result, the engine is required to deliver more power – and therefore use more fuel – to maintain the ship's speed. Eliminating growth on the hull will reduce the amount of fuel used

over time.

This is nothing new. Operators have been fighting fouling for centuries. But it is only relatively recently that hull coatings have become much more effective, environmentally benign, and able to protect a ship irrespective of its trading area or operational pattern.

This is important for the tanker sector where vessels on long-haul routes are trading from warmer to colder waters; where product carriers are operating in varied conditions; and where shuttles are often required to idle for lengthy periods.

Hull coatings have developed in recent years to include a range of products that include antifoulings (those that use biocides that are maintained at the surface of the paint by a polishing process); fouling-release (ultra-smooth coatings that prevent organisms from attaching); and fouling-defence solutions that combine the two prevention mechanisms.

Biocide

Until recently, it was impossible to create an ultra-smooth coating that also contained an effective biocide (chemical substance to kill harmful organisms).

In 2013 Hempel launched the world's first fouling-defence product, called Hempaguard. Hempaguard was able to achieve a super-smooth finish that contained a hydrogel layer at its surface. It is this layer that contains the biocide.

Because it is held at the surface with the hydrogel, its effect is maximised and only 5 per cent biocide is required when compared with traditional antifoulings.

Since launch, Hempaguard has been applied to more than 1,700 vessels saving the owners more than USD 500 million on their collective bunker bill.

Performance programme

Hempel's SHAPE (Systems for Hull and Propeller Efficiency) documents Hempaguard MaX's fuel savings to identify further efficiencies.

Based on ISO 19030, SHAPE is a tailored hull performance programme that makes use of Hempel's data analysts, chemists, physicists and hydrodynamicists.

Together, they monitor performance to allow the operator to make informed decisions on how best to utilise the vessel in terms of passage speed, idle periods and other factors.

SHAPE establishes individual speed/power reference curves for an individual tanker and then collects, cleans and purifies in-service data.

A series of precise speed loss calculations are then performed before delivering KPI measurements that relate to all stages of the tanker's operational life, its dry-docking performance, in-service performance, the maintenance triggers and the maintenance effects on vessel speed.

SHAPE delivers a transparent cost-effective solution, offering real savings to every operator, regardless of the age, size or operating pattern of the vessel, and using this methodology those savings can be refined and delivered year-on-year.

The ISO 19030 was developed to harmonise the way performance is monitored. Hempel's SHAPE takes this further, opening up hull and propeller performance to significant and ongoing operational improvements.

Continuous savings are vital for tanker owners to remain profitable, particularly in a low emissions environment. Investing in a truly effective and globally applicable hull coating provides part of the solution; and coupling it with a process that accurately measures and monitors its performance will add further to its overall effectiveness.

Shipowners' experiences of scrubbers

A London meeting of the Clean Shipping Alliance included a shipowners panel, where representatives of Spliethoff, Grimaldi and Genco Shipping shared their experiences with scrubbers

A meeting in London in February of the Clean Shipping Alliance (CSA), an organisation of shipping companies using scrubbers, included a shipowner panel, where representatives of Spliethoff, Grimaldi and Genco Shipping shared their experiences.

None of these companies are operating tankers. but their experience should be relevant to Tanker Operator magazine readers.

Spliethoff operates 50 multipurpose dry cargo vessels from 12,000 to 23,000 DWT.

Genco Shipping and Trading provides dry bulk transportation of iron ore, coal, grain, steel products and other drybulk cargoes, with a fleet of Capesize, Panamax, Ultramax, Supramax and Handysize vessels.

Grimaldi Group operators roll-on / roll-off vessels, car carriers and ferries. Shipping companies in the group include Atlantic Container Line, Finnlines (a ro-ro operator) and Minoan Lines (a ro-ro operator).

Happy with scrubbers – the shipowners panel at the CSA London forum. From left to right: Captain Robert Hughes, COO, Genco Shipping and Trading; Dario Bocchetti, head of Corporate Energy Saving & Innovation Department, Grimaldi Group; Arne Hubregtse, technical director and member of executive board, Spliethoff

Spliethoff

When asked about his experience with scrubbers, Arne Hubregtse, technical director and member of executive board, Spliethoff, said that it could be simply stated as "good".

"We have not had any major problems or any breakdown issues. There were some installation issues, but no major issues in operation," he said. "So we are quite satisfied, and look forward to operating for a long time."

Spliethoff has been operating scrubbers for about 10 years. The company decided to equip all of its vessels with scrubbers. There are about 20 further to go. The work started about 6 years ago.

The vessels operate in Europe's Special Emission Control Areas (SECA), with sulphur limits now of 0.1 per cent.

The scrubbers have been installed in a variety of vessels, including heavy lift and multipurpose vessels. There was no impact on overall cargo carrying capability, "apart from a minor deadweight reduction. Sometimes you have to sacrifice a fuel tank," he said.

The main reason for installation was risk management, with high levels of uncertainty about the availability and price of low sulphur oil, the alternative means of operating with low sulphur emissions.

"From the environmental point of view, a scrubber plus heavy fuel oil is the best intermediate solution," he said.

In terms of corrosion, Mr Hubregtse said the company did not have any corrosion issues. But "you do need to do your homework. Choose your materials correctly. You know what's potentially going to go wrong so focus on that."

When asked what he thinks the industry will look like in 10 years, his reply was that it is still an open question. "A lot of research is going on. We will burn fossil fuels and a combination of biofuels. We need to go to green fuels - green ammonia."

But there are many technologies and challenges to overcome meanwhile, such as improving energy density, storage, operating temperatures and pressures. "There is a lot of research going on by engine manufacturers to find a solution."

When assessing a fuel, it very important to assess the total amount of CO2 emitted, known as "well to wake", he said.

Grimaldi

Dario Bocchetti, head of the energy saving and innovation department of Grimaldi Group, said the company has a project to fit scrubbers on 100 vessels, which is now 70 per cent complete.

The project started in 2014 with vessels under two of its "brands", Finnlines, which operates ro-ro and passenger services in the Baltic and North Sea, and Atlantic Container Lines, which operates large roll-on/roll-off container ships between Europe and North America.

There were some installation challenges, with "congestion" at shipyards installing the scrubbers, with engineering work being the

main bottleneck, he said.

A retrofit has been possible in "80 per cent of cases." The work proved "very easy" compared to retrofitting a vessel to run on LNG fuel, he said.

A scrubber can weigh between 30 and 100 tonnes. In a few cases, there was a need to review whether it would affect vessel stability. Although a conversion to LNG propulsion, including carrying LNG tanks, would take up more space.

Grimaldi decided to "overcomply" with legislation, now reducing emissions to the equivalent of using 0.1 per cent sulphur fuel. It means "we have full control of the operation," he said.

The running hours for operation are "higher than 90 per cent," he said.

You do need to train crew how to use the equipment, and work out management processes. But "we don't see any big issues," he said.

Ships fitted with scrubbers today will still be using them in 10 years' time. "Exhaust gas cleaning systems is a good solution for ships in service [today]."

Scrubbers have been used for many years on land, and on ships for 10 years. So corrosion issues are fairly well understood now. "You need to apply proper measures," he said.

Genco

Captain Robert Hughes, chief operating officer, Genco Shipping and Trading, said the company is installing open loop scrubbers on its Capesize fleet of 17 vessels, the most recent of which entered service in January 2020.

Captain Hughes sees scrubbers as a mature technology, which has been used for many years, including on tankers to inert cargo tanks.

A great deal of thought has gone into how to implement the scrubbers. "If anything, we over-thought it," he said.

The company decided to have an extra engineer onboard to manage the scrubbers and also to reduce overall risks to the company.

It is important to have a plan around corrosion. "We operate in a saltwater environment and things do rust out," he said. "You need to have a plan of action in place as you would with any system."

You need to work out how much spares to carry.

"We've had no breakdowns, we haven't experienced any issues. But a lot of that is due to good planning, planning for performance. You must do the mental heavy lifting ahead of time, choose the right supplier, and identify where there could be some limitations and vulnerability.

But companies running vessels with low sulphur fuel also have to do a great deal of thinking and planning, he said. "The way we bunkered before 2020 is different to how we do it now. It requires more effort."

The overall environmental argument with the atmosphere could be to leave it better than you found it, as "I like to say to my kids at the camp ground."

The scrubbers can clean up sulphur to the same emissions level as if the fuel contained 0.1 per cent sulphur.

"As an industry we are getting better with air emissions, moving from 3.5% to 0.50%, and that's a step in the right direction, a solid step forward for improving air quality.

"Can we get better? Yes. I think that we should always challenge ourselves. I think we will begin to look at technologies that are already employed and look at ways of improving them. We just need to keep pushing ourselves as an industry to keep going and don't settle."

Mr Hughes was asked how Port State Control react to the scrubbers. "They are keen to come on board and have a tour of the system," he said. "They are keen to understand the different systems and technologies out there and see how they work. Every display is a bit different. They are very curious."

"It is important that we demonstrate what's going on and explain the science behind it."

In terms of future fuels, "it could be ammonia, hydrogen, biofuels in 10 years," he said. "But it is at nascent stages, based on what I'm reading."

About CSA

The Clean Shipping Alliance is a group of commercial shipping and cruise companies formed in September 2018, focussed on open- and closed-loop Exhaust Gas Cleaning Systems (EGCS), the more formal name for scrubbers, and associated air and water emissions.

There are 36 members. Members operating tankers include Blystad Group, Capital Ship Management, Chandris (Hellas) Inc., Delta Tankers, DHT, Dorian LPG, Eastern Pacific Shipping, Frontline, Golar, Hunter Group, ICBC, International Seaways, Laskaridis Shipping, Navig8, DS Norden, Okeanis, Olympic Shipping, Solvang, Torm, Trafigura, and Union Maritime.

The members have been involved in emission control efforts, and made investments in research and analysis, and in equipment, to comply with the 2020 fuel requirements using EGCS.

The stated purpose of the Alliance is to "provide information and research to better inform industry, national and international authorities, non-governmental organizations and the public on the environmental performance and benefits of EGCS."

TO

Scrubbers – corrosion, washwater and CO2

We heard about reducing corrosion, safety of disposing washwater in the sea, and the possible capability of a scrubber to remove CO2, from speakers at the Clean Shipping Alliance (CSA) forum in London in February

At the Clean Shipping Alliance forum in London in February, we heard about ways to reduce corrosion of scrubber material, the safety of disposing of scrubber washwater in the sea, and the possibility that scrubbers could be used to remove CO2 from flue gas as well as the sulphur.

On the topic of corrosion, Nigel Ward, director for promotion and market development with the Nickel Institute, an association of nickel producers, talked about approaches to minimise corrosion in the scrubber.

Scrubbers are typically made from alloys of chromium, nickel, molybdenum and nitrogen – with the nickel content of between 7 and 60 per cent. Pure nickel costs $13,000 a tonne. It has a good corrosion resistance, but if you want more nickel in the alloy you choose, your scrubber will cost more.

A different choice of alloys could be made depending on how long you want the scrubber to be in operation for and the expected service conditions. The different alloys also have different welding characteristics.

There can be a high price to be pay for having a substandard scrubber – if your exhaust gases are high in sulphur oxides (SOx)you can be refused entry to a port.

There is still plenty more data to be gathered about how the alloys used to make scrubbers corrodes on ships. This includes how the corrosion rate depends on whether they are "closed loop" (with the same water continuously circulating), or "open loop" which use and then dispose of sea water, he said.

Seawater is particularly corrosive. Scrubbers have been used for many years on land, and some shipboard installations have been made from the same materials.

The heat also needs to be considered, with gas entering the scrubber at 250 degrees C or more. The whole inlet area gets very hot. The rate of corrosion increases with heat.

Corrosion risks also need to be also considered during start-up and shut-down, he said.

The resistance of metals to corrosion can also be reduced by "weld spatter" (droplets of molten metal or non-metallic material that are scattered or splashed during the welding process), markings under paint, and heat effects on welds. The welder training can be "extremely important", he said.

The design of the scrubber can be as important as your choice of material, because corrosion can start in crevices or holes.

Wash water discharges

A number of countries have announced bans on the discharge of water from open loop scrubbers in their ports due to concerns about pollutants. Open loop scrubbers put seawater in contact with the flue gas to wash out the sulphur. The water is then treated and monitored, and treated washwater is discharged to the sea.

The Cruise Line Industry Association (CLIA) commissioned Dutch environmental consultancy CE Delft, to look into these concerns. The research was done jointly with a research company called Deltares, which focuses on water.

The research was presented Dagmar Nelissen, senior researcher/consultant for CE Delft's Mobility & Transport Department.

The study looked at having a vessel in the berth with the engine running with a scrubber, for a certain power generation per year (equating to a certain amount of fuel consumption and scrubbing per year). It was equivalent to a ferry being in the berth for 12 hours per day.

The concerns are about the "residence time" of any pollutants in the waters around the vessel, not just the discharge itself. This depends on the shape of the berth, the tide and currents.

So the study looked at ports with different "geometries", including river ports, ocean ports, Baltic Sea port, the Port of Rotterdam. Each of these have different tidal patterns and berth shapes, which affects the rate that any pollutant was dispersed.

The study results were surprisingly good, Ms Nelissen says, with the highest pollutant only presenting at 6 per cent of the maximum allowed amount under the quality standard. So it would be possible to leak 16 times as much without going over the standard. These chemicals are also already present in tiny amounts in seawater (known as the 'background').

The study was based on water samples taken from around 291 vessels, and analysis

for 27 substances, including 11 metals and 16 hydrocarbons.

Using alkaline water scrubbers

At the Clean Shipping Alliance forum, maritime technical consultant Dr Robert Allen talked about the possibility of using alkaline water in a scrubber to remove all exhaust acidic gases (CO2, NOx as well as SO2 and SO3).

It may be possible to remove over 50 per cent of the CO2 and NOx in an exhaust gas scrubber and thus meet IMO 2050 requirements. (Although the CO2 reacts to form carbonic acid or sodium bicarbonate, which would need to be handled somehow).

The alkalinity of alkaline water is determined by the concentration of hydroxide ions which will readily react with acidic gases, he said.

A two-stage scrubbing system would need to be employed. The SOx are reduced in the first stage, and CO2 and NOx removed in the second stage.

The key aspect is that SOx is some 50 times more soluble in water than either CO2 or NOx so removing the S0x first would allow scrubbing of the CO2 and NOx.

In the first stage conventional sea water scrubbing is employed and SOx reacts with the calcium carbonate.

In the second stage, CO2 reacts with the hydroxide ion to form carbonic acid (H2CO3) or sodium bicarbonate (NaHCO3) if sodium hydroxide is employed.

One company in Singapore called Ecospec developed a commercial version of creating alkaline water using hydrolysis.

In test reports (which are online at http://www.ecospec.com/resources/ck/files/CSNOx.pdf) it claims to reduce 99 per cent of SOx, 66 per cent of NOx and 77 per cent of CO2, at a 33 ton / hour gas load.

Dr Allen developed a lab-based version to create alkaline water cheaply.

One challenge (for using it onboard a ship) is creating large volumes of alkaline water. Dr Allen suggests using small tourmaline ceramic balls, which are used in home water filters to make water alkaline. It is available in large volumes for $2000 / tonne.

Using a small fluidised bed reactor containing ceramic tourmaline balls and a 24 Watt pump, Dr Allen was able to make 4 litres of water with pH of 9.5 in 10 minutes. Scaling up for a ship, this works out to making 20m3 / hour water at a pH of 9.5, at a cost of under $10 per hour. It would require 70kg tourmaline a month at $5 / kg, equating to 0.5$ / hour to buy the tourmaline.

"This is early work but if the challenges of meeting IMO 2050 are to be addressed all technologies need to be explored," Dr Allen said.

TO

Hyde Marine – perspectives on tanker ballast water systems

We interviewed Mark Riggio, senior market manager with Hyde Marine, a UV ballast water equipment supplier, about how he sees the current picture for tanker operators installing ballast water systems, with new IMO requirements next October

There are "unique challenges of the tanker space" with ballast water systems, "which the industry has not yet unpacked and understood," says Mark Riggio, senior market manager with ballast water equipment manufacturer Hyde Marine, based in Pennsylvania.

The big incoming issue is a change to requirements for new ballast water systems on October 28, 2020. Systems installed after this date will need to meet a set of requirements known as "Revised G8" or MEPC.300(72). It is not currently clear which companies' systems comply with the new rules, Mr Riggio says.

Note, these rules apply to new systems installed after Oct 28, not to systems installed before that date. But tanker companies making orders for new systems now (April 2020) probably would not have them installed before this deadline.

If ships have new ballast systems installed after Oct 28 which do not meet the G8 requirements, they will not be able to enter most of the world's ports.

The G8 requirements were developed following concerns that some ballast water systems would not be as good as they needed to be in removing microbes from water. The guidelines were originally defined in 2005 and underwent a critical revision in 2016. The push for the revised G8 guidelines was driven partly by customer organizations like the International Chamber of Shipping (ICS).

Under the initial guidelines, all new build ships must have had a "D2"-compliant system for ballast (shipboard microbe removal system) since September 2017.

Existing ships have the option of "D1" system (where ballast water is exchanged in deep water before the vessel enters port), but they must have a D2 system by the time of the ship's first International Oil Pollution Prevention (IOPP) Certificate renewal survey after 8 September 2017. Certificates last for 5 years usually, so that means by September 2022.

Thinning out of suppliers

According to Hyde Marine's internal research, there are only 13 systems that have this new G8 certification. "There are some surprising names that are not on our list," he said.

IMO used to publish lists of which companies were certified, but "they stopped doing that," he said. "Now we rely on Flag Administrations to tell the IMO that they have issued these new certifications."

About 60 ballast water equipment manufacturers got the original IMO certification – so if there are really are only 13 companies certified to the new standard, it means about 75 per cent of suppliers may be leaving the market.

A thinning out of the ballast water supply sector may be good news for the suppliers which survive, because having 60 suppliers in the market made it very hard to make any margin. "I would contend that everyone is basically selling at their marginal price," he says.

Also, the market offerings of the suppliers had little differentiation, with the industry consolidating around two technologies, electrochlorination and ultra violet (UV) light.

Mr Riggio notes that many of the ballast water companies are funded by investors, who thought they were investing in a safe market in 2012, due to ships being required to carry the equipment.

Testing for the original IMO certificate would have cost $1m to $4m, he says. Then the USCG came up with a tougher standard. Testing for that standard would cost $4m to $10m. So the investors had to spend between $5m and $14m for two sets of testing, without necessarily selling many systems.

Testing for IMO's G8 standards means more expenditure. There is some overlap with the USCG standard, but not a complete overlap. So it is possible that your USCG test gets you through G8, but not a certainty, he said.

Each test round takes 18 to 36 months to get done. The restrictions on travel during spring due to coronavirus makes it harder to meet the October deadline.

Hazardous classification

Tanker companies, unlike many other types of shipping, additionally need systems which have Ex certification (classified as safe for use in hazardous areas), since the vessel is carrying fuels which can catch fire.

Ballast water systems have two different explosion concerns. The first is that cargo fuel tanks are usually next to ballast water tanks. There are concerns that the steel between the tanks may corrode, so fuel enters the ballast water. So ballast water can potentially contain explosive fuels.

The second concern is that ballast water systems are typically placed in hazardous environments, such as the deck or pump room, and so there cannot be any spark from the equipment in case it ignites any explosive gases in the surrounding air.

So there are concerns about both the internals and externals of the system. Being explosion proof for both at the same time can make the system design very challenging.

To add to the potential hazard, electro chlorination (EC) systems, which are popular with tanker operators, release small amounts of hydrogen, which is itself hazardous.

"It is not that simple to get a ballast water treatment system Ex certified," he says.

USCG standards

The US Coastguard standards, required for vessels visiting US ports, differ to the IMO standards in that they require microbes to be killed, not just sterilised.

Whether ultraviolet light kills microbes, or just

sterilises them so they cannot reproduce, depends on the power of the lamp. You typically need three times more power to kill microbes, Mr Riggio says.

For a mid-sized tanker, it could mean 500 KW to a megawatt of power. Having generators onboard which can make this much power is not very popular in an age where companies are trying to reduce greenhouse gas emissions.

And the power you need also depends on how much sediment is in the water, which impedes the power of the light through the water. If the vessel has taken on ballast in a river, it is likely to have much more sediment.

Sediment in ballast water is actually usually less of an issue for tanker operators than for operators of other types of vessels, because tankers do not typically go up rivers much, because they need a deep draft.

Companies using UV for ballast water systems on tankers in the US will typically use three methods to make it work – increasing the power, reducing the water flow, and removing sediment from the water (or only using ballast water with a low level of sediment), Mr Riggio says.

EC vs UV systems

The tanker market seems to be consolidating around two methods for handling microbes - electro chlorination (EC) and ultraviolet (UV), Mr Riggio says.

Tankers generally have much larger volumes of ballast water than other types of ship, which pushes them to a certain class of systems.

An advantage of EC systems is that the power requirement is usually lower – 500KW to 700KW for a Suezmax or VLCC, compared to 2MW for UV, he says. The enormous UV power requirements are largely due to the US Coastguard requirements described above.

An advantage of UV systems is that they are much simpler to operate, not requiring any specialist knowledge, Mr Riggio says. "It's a very simple process. It really doesn't add much to the crew's burden if designed properly."

Electro chlorination systems mean handling chemicals. The electrical power in salt water causes sodium chloride (salt) to react with water to form sodium hypochlorite (NaOCl) and hydrogen. The hydrogen has to be vented off, and the sodium hypochlorite kills the microbes.

These chemicals can gradually wear down cargo tank coatings, the gaskets, valves and seals, he says. There are risks of killing other organisms around.

The chlorine in the water needs to be continually measured using a "Total Residual Oxidants" sensor, to ensure it is not so high as to itself be a pollutant in the water going overboard. Mr Riggio says that this sensor can be "very finicky".

"An EC system is a completely unique piece of equipment on the ship," he says.

A further weakness of chlorination systems is that they are sometimes not so good at adjusting to changing flow rates, Mr Riggio says.

This is very important for tanker operators to understand. The vessel will typically be pumping in oil and pumping out ballast water at the same time. The oil and ballast water go in different tanks, but the flows need to be matched to ensure the vessel is stable but not overloaded.

If the ballast water is not treated fast enough, there may be a need to slow down oil pumping.

"You end up trying to call the port, 'slow down the pumps'. That's sometimes more or less possible, but it's a delicate balance that crews have to be careful about," he says.

Ballast water equipment news

Some news from Alfa Laval, Optimarin, Hyde Marine and Techcross

Alfa Laval's PureBallast 3 UV system has IMO revised G8 type approval, and was one of the first to receive it in February 2018, the company says.

It followed tests with marine, brackish and fresh water being completed under the new G8 regime in Q3 2017.

Optimarin and SunRui co-operation

Ballast water companies Optimarin and SunRui announced a "strategic market co-operation" in March 2020.

Optimarin, based in Sandnes, Norway, makes ultra violet ballast water systems. It says it offers the world's first US Coastguard approved UV system, and the systems are mainly installed on medium and small size vessels.

SunRui Marine Environment Engineering Co Ltd, based in Qingdao, China, offers electrolysis based (electro chlorination) ballast water systems, which, it says, are more suited for medium to large vessels.

Some shipping companies with a range of sized vessels in their fleet may have both systems.

The two companies will now cooperate in the global market, tailoring customized services for different shipowners and vessel types, and going forward consider the possibility of future supply chain and after sales service cooperation.

"By working together we can, for the first time, offer those companies a complete sales and service one stop shop, where all their needs can be met through a single fleet agreement, with the best available technology on the market," says Optimarin CEO Leiv Kallestad.

"This simplifies procurement and delivers the long-term peace of mind and performance they [shipowners] need."

Hyde Marine chemical tanker

Hyde Marine's "Hyde GUARDIAN" UV system was selected by Kurinoura Dock Yard in Japan to be installed on chemical tanker Marex Sara.

The client looking for a system which could handle 350 m3 / hour flow.

Hyde Marine makes systems designed for 300m3 and 450m3 – so there was a choice of constraining to a lower flow rate and using the 300m3 model HG300GX, which was the shipyards initial choice. But this would mean ballast operations taking more time, so owners decided on a 450m3 unit.

All of the system needed to be explosion certified.

The piping system was arranged with the flow through the ultra violet chamber going upwards. This means that any air does not get trapped in the chamber, which can create a potentially dangerous situation.

A Sunrui BalClor ballast water management system

Techcross patent

Techcross of South Korea entered into a patent transfer agreement with Mitsubishi Shipbuilding Co., Ltd. and Hitachi, Ltd. to receive the patent for a ballast water management system (BWMS) installation solution.

The transfer of rights will be completed by the beginning of June 2020 at least as each country finished administrative procedures. The patent is recognized in four major shipbuilding countries including Korea, China, Indonesia and Philippines.

The patent was originally registered in 2011. It covers a ship structure solution enabling the installation of BWMS in appropriate locations regardless of the ship type and ballast water treatment methods used.

The comprehensive installation solution handles the installation location of direct/ indirect electrolysis equipment and pipe structures of UV and electrolysis equipment.

The solution is unique because BWMS can be installed near the bridge towards the aft of a ship, allowing effective use of spaces in the ship. As such, ship structures or hull shapes do not need to be largely modified to install BWMS when using this solution. This also means that BWMS can be easily installed on new and existing ships alike, Techcross says.

As of 2020, Techcross holds 115 patents and utility models regarding BWMS, related technologies, and installation solutions.

Techcross says it had 152 million dollars in sales in 2019, which is a 230% growth compared to the previous year. Techcross is continuing its business in 2020 with a goal of doubling the sales figure to 295 million dollars.

TO

Air cooled power supply for EC ballast water treatment

When running electro chlorination (EC) treatment in ballast water management systems (BWMS), you need to cool the power system. The power system converts shipboard AC into high current DC, which EC requires. KraftPowercon has developed their first air cooled power supply especially designed for BWMS.

Electro chlorination ballast water systems are proving very popular with tanker operators – but one complexity is that the power supplies that generates the direct current also generates heat that needs to be removed.

One way to remove the heat is to use cooling-water, which also has its own complexity, requiring pumps, protection from the vibration of the ship, and connection to the shipboard water supply.

A failure in the system might make the whole ballast water system un-operable, which in turn might mean that a ship is unable to load, or un-load, cargo.

But KraftPowercon of Sweden has developed a way to cool the rectifiers using air – thus making the systems less complex.

This makes electro chlorination ballast water systems more viable in general.

Water cooled systems need protection from the vibration of the ship, using dampeners – while air cooled systems don't. Dampeners are like shock absorbers on a car, stopping the vibration of the ship transferring to the unit.

But this adds extra cost and complexity to the installation, because it means that every connection to the unit, including pipes and cables, needs to be flexible. Dampeners are also expensive.

Air cooled systems, in contrast, are robust enough not to need dampeners at all.

The air cooled system system was developed after some customers found they were not able to use water cooling for their rectifiers for various technical reasons, says Göran Stenmark, Global Product Manager with KraftPowercon Marine division.

Water cooling has greater capacity to absorb heat, but air cooling "can be much easier to install and set up," he said.

"You don't have to hook it up to the water-cooling system on the vessel, you just make sure you have enough air – and you're good to go."

"We had to spend a lot of engineering hours, thoughts and extensive tests when developing and designing this unit that will last, even though it is really vibrating hard," he says.

KraftPowercon's rectifiers are available as part of ballast water treatment systems from seven different suppliers - De Nora Water Technology, Envirocleanse, ERMA First, Evoqua, RWO Veolia, TeamTec OceanSaver and Wartsila.

Killing microbes

The process of electro chlorination systems is that An electric current is run through a cell containing flowing sea-water. The electrical energy breaks down salt (sodium chloride) in the seawater, which then reacts with water to form hydrogen and sodium hypochlorite.

The sodium hypochlorite is then passed into the ballast water tanks where it will kill any organisms that passed through the filter. The small amounts of hydrogen are vented out with fans.

Electro chlorination systems will work on any kind of vessel, but tend to turn out to be a particularly good fit for larger sizes of vessels, he says.

ECKraft

The air-cooled rectifier, called ECKraft, is designed to work at ambient temperatures of up to 55 degrees C, enough for Saudi Arabia and Qatar, both of which have seen maximum temperatures in the lower 50s.

It meets the "IP44" standard for protection against intrusion, dust, accidental contact, and water, which means it is protected against splashing of water, and physical objects up to 2.5mm, such as wires and screws.

The output can be up to 240 volts and up to 15,600 Amps DC.

The system has been designed with redundancy – it is built up of a number of smaller power supplies working together, and systems are normally not running on 100 per cent load. So one module can fail without bringing down the whole system.

ECKraft has been type-approved by the certification bodies DNV GL and will be approved by the Korean Register in the first quarter of 2020. This type approval confirms that the product meets all requirements from the New IMO G8, IACS E10 Rev 7 and USCG.

KraftPowercon

The rectifier is designed and manufactured by the KraftPowercon team in Sweden.

KraftPowercon manages all of the testing and type approval process independently, making it much easier for companies to include in their Systems. They just need to submit pre-prepared documents to their class society, Mr Stenmark says.

With the same company doing manufacturing and managing testing, also makes it easier to make any modifications.

KraftPowercon specialises in power systems for harsh environments, including making units for electrostatic emission cleaning systems in heavy industry, and gas turbine back-up power systems on offshore oil and gas platforms.

Kraft PowerCon has been supplying power systems since 1935, and been in the marine business for 20 years. It focusses on energy conversion systems, including low voltage high current systems (as in this case), low current but high voltage systems (as required by the electrostatic precipitators, cleaning air from chimneys). A third application is uninterruptible DC power systems for the oil and gas industry.

It has a global service network to fix any problems.

The company got involved in ballast water rectifiers, after a background selling power supplies to a number of water cleaning installations.

TO

Developments with ice class modelling

Improvements with ice class computer modelling can facilitate tanker trade along the Northern Sea Route and the North American Arctic

By James Bond, director, Polar Research & Ice Class Ships, ABS

To better model ships in ice, ABS is developing a simulation technology called "event mechanics", together with researchers at Memorial University of Newfoundland (MUN).

By using event mechanics, designers and class can evaluate how different designs for ships and offshore structures will behave in different ice conditions.

Event mechanics means modelling complex problems as a series of discrete events. One thing happens then another thing happens.

Problems in real life can often happen as a series of events – some corrosion in one area leads to weakening in another which leads to wear somewhere or components corroding in a complex way.

The previous approach is continuum mechanics, where researchers examine the behaviour of materials as a single mass.

The simulation process is called "General Event Mechanics (GEM) simulation", a numerical technology, based on mathematical models of the physical system.

By running GEM to calculate how different components will behave it is possible to determine how different forces and conditions will affect them.

It can be used for evaluating both the risks of standard ocean-going ships in low impact icy conditions, and low ice class ships.

It can also be used to analyse how well floating structures can stay in their position, when subjected to different ice concentrations.

Predictions

In the realm of ship operations, it might be possible to integrate the mechanical modelling with analysing imagery, radar and 3D laser scanning, to make better predictions of what will happen.

For example it could be used as part of a collision avoidance system, or route optimisation guidance, together with data with predictions of future ice conditions.

It's also possible that the industry can begin to apply artificial intelligence and machine learning to compare ice conditions and temperature profiles with data from previous years and make projections by region.

ABS' Director James Bond

The work already achieved on safe speed in ice could be the foundation for the greater use of sensors to monitor operations and understand better the conditions in which ships can safely operate.

Longer term

In the longer term, this could lead to the further optimisation of ship structures that make them more efficient for ice operations once the limits are better understood.

These factors create the opportunity for progressive organizations to combine data and insights to drive efficiencies.

The intention would be to provide a level of safety acceptable under the Polar Code that could enable shipowners to undertake voyages with a high confidence factor based on data.

In particular, these changes will facilitate growing tanker trade opportunities in at least two areas. Reduced sea ice especially along the Northern Sea Route is already creating east bound transit opportunities for tankers and gas carriers from the Yamal region.

Despite its controversial profile to some, development of North American Arctic oil and gas in the future is likely. Work on establishing enhanced safety criteria now will make it possible sooner.

It is becoming clear that as overall sea ice extents are reducing, the mobility of multi-year ice is increasing. As a result, going forward, PC6 and PC7 ice class ships should become the workhorses for polar shipping, displacing IA Super and 1A ships from the marketplace.

The PC6 and PC7 ships are intended for first year ice operations but unlike their Baltic rule cousins, the Polar Class rules implicitly account for the likelihood of encountering multi-year ice inclusions.

Balancing climate concerns

Propulsion power, along with hull form, are the key characteristics that enable transit in ice.

But the intention of the IMO Energy Efficiency Design Index (EEDI) is a trend to reduce installed power for all ships. Lower ice class vessels and non-ice strengthened ships are subject to EEDI.

We need to reconcile the opposing needs of more installed power to get through ice, and less power to improve or be EEDI compliant on conventional ice class ships.

Icebreakers are typically higher ice classes (PC1 thru PC5) and as such are exempt from the EEDI.

These specialized ships provide assistance to keep other ships moving. They have a specific role in support of shipping operations in areas including the Baltic Sea, along the Northern Sea Route and in the Gulf of St Lawrence.

Harsh Environment Center

To facilitate the continued development of the tools needed to improve safety of ice operations, ABS established a "Harsh Environment Technology Center (HETC)" on the campus of Memorial University in St. John's, Newfoundland and Labrador in 2009.

The primary objective of the HETC is to develop technology for the design and assessment of ships and offshore structures that operate in harsh environments particularly the Polar regions and low temperature areas.

Newfoundland was considered a prime location to establish an Arctic research center due to its excellent educational program, offshore oil exploration and development activities in the region, and progressive approaches in supporting research activities. TO

How LNG operational practise is changing

Witherby Publishing has released the 2nd edition of its handbook for LNG carrier operations "LNG Operational Practise". We took the opportunity to ask the authors about the ways LNG operational practise is changing, and why they wanted to make a new edition

Witherby Publishing Group released the second edition of its handbook for LNG carrier operations, "LNG Operational Practice," dated January 2020.

It is written for LNG professionals as a way to update themselves about processes for operating an LNG carrier.

It is written as a practical reference aid for onboard use and a comprehensive study tool that provides practical knowledge of all procedures, from beginning to end.

This book aims to strengthen common procedures, focussing on the industry standard for each procedure, regardless of the LNG carrier or company, Witherby says.

This book is for all professionals in the LNG industry, whether they work on the ship or ashore. It covers not only operational control, but also additional operations as part of the life cycle of an LNG carrier, such as coming out of dry dock, post dry-dock procedures and gassing up.

Witherby is a specialist publisher of operational guidance and technical standards for the shipping industry.

Changing fleet

"With so many changes and developments in operations and technology [of LNG carriers], an update on the first edition was essential," a Witherby Publishing Group spokesperson says.

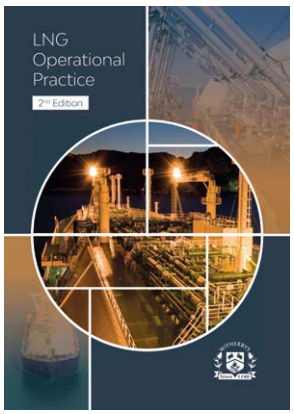
One of the biggest changes since the first edition was published in 2006, is that the LNG fleet size has increased fivefold and the industry is experiencing a further boom, with almost 50 newbuilds ordered in 2018, 60 in 2019.

The orders for Qatargas' fleet replacement, and Anadarko's Mozambique LNG requirement for a further 16 LNGCs, are also expected to be placed in 2020.

These new LNG operators, and new generations of LNG carriers, bring different approaches to the operation of the latest technology and equipment.

We see new types of dual fuel engine, using a direct mechanical drive with two-stroke dual fuel low speed engine, either high pressure (ME-GI engine) or Low pressure (X-DF engine).

The second edition reflects the technology in use onboard today's LNGC fleet, rather than the conventional steam turbine utilising boil-off gas that dominated for over forty years.



"A recent move toward the re-utilising of boil-off gases to prevent burn off in atmosphere will have good environmental impact. This is another process that is covered in the new edition," Witherby says.

Writing the book

"The book was written in-house in collaboration with external consultants from within the LNG industry who brought a range of perspectives and expertise on the subject. They included current serving LNG deck officers and former LNG superintendents, providing the best combined knowledge from both on board the ship and ashore."

"With such a technically complex subject matter, narrative can be difficult to follow. However, seeing the information clearly labelled and laid out in 3D drawings guides readers through such operations."

It utilises 3D imagery and is laid out with clear diagrams, checklists, guidance and instructions for each of the operations undertaken at each stage of a typical trading cycle for an LNG carrier.

The need for learning

"LNG is traditionally a safe industry that has always focused on environmental protection and has required the highest safety standards to be adhered to. Of course, there is always room for improvement," Witherby's spokesperson says.

"All mariners are trained to high international standards, but LNG operations require a different skillset that is beyond basic maritime training."

"Keeping key publications such as LNG Operational Practice up to date is an important element within the information pool available to them."

Brunvoll – "70% of shuttle tanker thruster market"

With a contract from Malaysian shipping company AET, Brunvoll says it now has 70 per cent of the market for thrusters for dynamic positioning systems on shuttle tankers, based on vessels it estimates are in operation around the world

Norwegian thruster manufacturer Brunvoll has signed a contract with Hyundai Heavy Industries for three 155,000 dwt shuttle tankers being built for Malaysian shipping company AET. They will be put into operation in oilfields outside Brazil.

The tankers will be fitted with two "tunnel" thrusters and three retractable azimuth thrusters (which can provide thrust in different directions), with a total power of 13,700 kW.

This is one of the largest single orders in Brunvoll's history. It follows a similar contract for five vessels ordered by AET being built by Samsung in South Korea.

Retractable Azimuth Thruster

Testing area

Brunvoll calculates that it has a 70 per cent market share of dynamic positioning systems for shuttle tankers, based on there being 84 vessels in operation (under 20 years old, usually the maximum age oil companies allow) and on order in the world.

The contracts mean that Brunvoll's production facility in Molde, Norway will be running at "high capacity" during 2020.

"With this contract and several other deliveries to the same segment, we are consolidating our position as preferred partner for thruster systems for DP shuttle tankers for leading players with operations in the northern regions and in Brazilian waters," says Per Olav Løkseth, marketing director at Brunvoll.

"This order makes us optimistic about winning further contracts for delivery of our propulsion and thruster systems to shuttle tankers that are in the planning process, both in the short term and in the years to come, as the shipping companies renew their fleets."

"We are committed to optimizing our complete solutions for propulsion and manoeuvring systems for the next generation of shuttle tankers."

Careful attention is made to the design of the propeller nozzle (the metal ring around the propeller), the propeller blade, and the thruster body, to achieve the optimum hydrodynamic design, which means maximum thrust for energy used, with minimum vibration.

Brunvoll has participated in a number of joint industry projects over the past few decades to find an optimum hydrodynamic designed propeller.

The thrusters are used as part of the vessel's dynamic positioning system, keeping it in a fixed location without needing mooring, such as for loading at offshore oil platforms, enabling the tanker to stay close to the platform but without risking colliding into it.

They are not normally used by regular tankers, which are able to rely on tugs for support.

TO

MENAS – please pay "Nav dues" in Middle Eastern ports

Middle East Navigation Aids Services (MENAS), which maintains buoys and DGPS in the Middle Eastern Gulf, would like to request that shipowners pay their invoices after Middle East port calls the as the dues are needed to mantain the existing service and upgrade equipment

Middle East Navigation Aids Services (MENAS), is a not for profit organisation which maintains buoys and DGPS in the Middle Eastern Gulf among other services, would like to request that shipowners pay their invoices which are issued to them after their Middle East port calls.

If the invoices are not paid, MENAS will be unable to keep maintaining the equipment, leading to safety issues and GPS inaccuracies, explains Peter Stanley, CEO of the parent charity International Foundation for Aids to Navigation (IFAN).

Background

Having aids to navigation managed byan independent company, and not a government, is an unusual situation, but linked to the background to maritime shipping in the region, Mr Stanley explains.

It goes back to earlier in the 20th century, when UK and Indian governments were involved in keeping trade flowing in the region, and the coastal states did not yet exist. (For example, UAE, Bahrain and Qatar were founded in 1971). UK and India took responsibility for providing buoys in the Gulf for safety of maritime transport.

After these coastal states were established, the UK and Indian governments thought they should take over responsibility for the navigation aids, but they have not so far. So MENAS was established as a charity with responsibility for maintaining the aids.

MENAS has continued trying to encourage these coastal states to take responsibility, but so far only Oman has agreed to do so, since 2000. MENAS provided initial technical support to Oman for establishing the aids around Oman territorial waters 20 years ago, and is still providing support through participation in a joint-venture.

Some coastal states are providing navigation aids within their territorial waters, as international law requires, but not beyond this into international waters .

So MENAS continues to hold responsibility for maintenance of them to this day.

The costs for maintaining the service is covered through an invoice for "Navigation Dues" which is presented to owners by ship agents when vessels visit Middle Eastern ports. It is free for vessels under 15,000 NT. Larger vessels pay $1.68 per 100 net tonnes, so a 40,000 NT vessel is invoiced $660. The fees are capped at that level, so a VLCC is also invoiced $660.

But MENAS relies on ship opwners to recognise thier "moral obligation to pay for the services enjoyed as they transit the gulf" Mr Stanley says.

There are some "really good owners", who understand they have used MENAS' services, and pay the Nav dues along with their port dues, when the invoice is presented to them by the agent.

But some operators don't – either because they perhaps they don't understand who provides the service, or just make a choice not to pay, he says.

MENAS finances

MENAS' parent organisation IFAN, a registerted UK Charity, has an income of around £10m year according to public fillings. IFAN supports projects furthering safety at sea through improved aids to navigations and education.

In the past, there was a time when MENAS had a bigger income than it needed, and so money was donated to bodies which promote safe navigation at sea, and the dues were reduced.

Today, funds are needed to renew the DGPS stations, which are coming to the end of their 20 year life. The funds are also needed to keep operations running at the current level, promoting safe navigation in the waters of the Gulf.

To supplement its income, MENAS provides some consulting work, including risk assessments on behalf of port authorities, and from October 2020 it will start providing training for Aids to Navigation technicians, accredited by IALA, targeting staff from Gulf port authorities.

MENAS owns a buoy tender vessel, built in 2004, which it used to keep the buoys refuelled with acetylene gas. But today, the buoys are solar powered, so this is not required. So the vessel has been chartered out on the spot market, and it is currently supporting North Sea projects, working on subsea operations, pipelines and wind farms. This brings in some revenue.

The fact that MENAS is independent of any state body can also have some appeal, in this part of the world.

MENAS Board

MENAS board members have a deep background in tanker operations and other areas of shipping.

Chairman Alan Marsh is a former CEO of Braemar Shipping Group and director of ITIC.

CEO Peter Stanley formerly held a variety of roles in BP, finally as head of control in BP's corporate segment.

Director Robertus Brummer currently also serves as Senior Director Group Procurement with Maersk A/S.

Director Guy Mason currently serves as COO of BP Shipping Ltd.

Director Captain John Hughes is formerly operations VP of ExxonMobil's international oil and gas tanker fleet and director of OCIMF.

Director Captain Yousef Al Saqer is presently Manager Fleet newbuilding projects KOTC, formerly Manager fleet marine operations KOTC.

Director Captain Tomoyuki Koyama is presently Chairman and Chief Executive Officer of NYK Ship Management Pte Ltd.

Director Captain John Evans is currently Global Manager Maritime Security and Fleet Q&HSSE with Shell Transport & Trading Company.

TO

Robert Lloyd - Artist

Robert Lloyd is a marine artist based in Wiltshire, UK, who has been painting for ship owners, managers and builders for 25 years, with clients including MOL, Ionic, Lykiardopulo, SeaRiver/ Exxon, Thome, Diamond S', Navigator Gas, and QatarGas.

His work features in the public collections of the Smithsonian Institute, the MIT public Art Collection and the private collections of various members of the British, Norwegian, Dutch and Danish Royal Families as well as Emir of Qatar, Kuwait and Saudi Arabia.

A specialism is large scale paintings up to 6x6 meters (approx. 20x20 ft.) which have high impact in public spaces such as reception areas, exhibitions, museums and other public areas as well as on-board ships.

Growing up, he often spent time watching ships in the River Mersey entering and leaving the Port of Liverpool. He considered a career at sea but was persuaded by teachers to go to art college instead, and found work in an advertising agency, which had a number of shipping companies as clients. One client, P&O, asked him to produce a painting of one of its new ferries, leading to further commissions to paint ships. Mr Lloyd ended up leaving the agency to work as a full time painter of ships.

See www.robertglloyd.com

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