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Contents

Where is tanker shipping going - based on looking at oil and gas

The tanker shipping industry is, broadly speaking, a supplier to the oil and gas industry, and heavily influenced by changes in the oil and gas industry. And this is an industry going through big changes. For an illustration, have a look at BP's new corporate structure, which you should find by Googling "Reinventing BP".

Out of the top 12 roles, we have one person looking after shipping and trading. We also have a top 12 person in charge of strategy and sustainability, people and culture, communications and advocacy, gas and low carbon energy, all of which may have a role which relates to BP's shipping activities.

BP barely talks at all in public about its approach to tanker shipping, but there are of course plenty of private discussions, and BP is a major trendsetter in the oil and gas industry in general. And we are seeing many themes come through into the public announcements made by the tanker shipping industry and its suppliers.

But based on BP's current priorities, as defined by the roles of the people in its top 12 team, here are some guesses about how the tanker industry will be driven to change over the coming few years - and in may ways is already being driven to change.

PEOPLE - as we heard in our Hamburg forum last October, the oil and gas industry will be pushing the 'human factor' to be handled in far more sophisticated ways by its supplier companies. It is no longer enough just to write a procedure after any incident designed to stop that incident happening again. Seafarers have more procedures than their minds can comfortably handle, and sometimes the procedures even conflict. Also there is growing frustration at the use of the term 'human error', almost as a simple excuse after any incident occurs.

So we can anticipate seeing tanker companies pushed to be far more sophisticated about how they manage the way people learn, how they create a manageable working environment, how they make sure procedures are easy enough to understand and follow, and how they approach aspects of management which are not linked to procedures, such as making sure seafarers feel supported by their employers, they feel empowered to speak up if they see something unsafe or are asked to do something they feel is unsafe.

CLIMATE - So far, improving CO2 performance in tanker shipping has largely meant looking at fuel consumption and trying to find ways to reduce it. This only takes us so far on CO2. The next step is to look at lower CO2 fuels, including methane, hydrogen, biofuels, methanol and LPG. There is a good overview of the options in this issue written by Georgios Plevrakis, Director of Global Sustainability, ABS.

COMMUNICATIONS - Oil companies care very much about how they present themselves - but unlikely to see tanker shipping as a positive, more a possible source of very bad news. But, as we heard in our Hamburg forum last year, they see a better approach to the 'human factor' as the best way to make further step changes in safety, rather than creating new procedures.

GAS AND LOW CARBON ENERGY - we can start to see a bigger picture of how this 'zero CO2' energy picture will pan out - a lot more renewables - but a lot of gaps between the renewables, which will need to be handled by gases. Methane, hydrogen and LPG as fuels, and CO2 which needs carrying away for sequestration. This implies a growing role for gas shipping of all kinds - more LNG shipping on a big scale, more LNG, hydrogen and CO2 shipping on a smaller scale.

COST COMPETITION - this BP web page shows lots of smiling faces, but bear in mind behind the scenes this company has completely changed around its top level structure. It is hard to imagine many large organisations making such a big move - because a lot of people will end up upset because their faces are not on this web page. The company made this big change because it is in a brutal operating environment, with big challenges to keep costs down while keeping the environmental story up.

I can see two ways this cost competition can impact tanker shipping. On the downside, it means that the pressure will continue on tanker companies to be efficient in their operations and their own purchases, particularly with fuel. On the upside, it might mean a bigger push towards floating offshore oil and gas production operations, including floating storage, which is an area the tanker shipping industry has major expertise. Particularly if it means fairly simple offshore structures for storage, not like billion dollar FPSOs, but more like tankers.

One area where upstream oil and gas isn't making as much progress as it expected is in use of digital technology. There's a lot of sensors being installed but very slow progress being made in making use out of the data to support decisions. In BP's new structure, digital technology is buried in the "innovation and engineering" role I would guess. And the head of "innovation and engineering" is a petroleum engineer, not a digital specialist.

Karl Jeffery, editor

See https://www.bp.com/en/global/corporate/who-we-are/reimagining-energy/reinventing-bp.html

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The FPSO market – what tanker operators should know

Three lawyers from London law firm Haynes and Boone LLP present an overview of what they see happening in the market for Floating Production Storage and Offloading (FPSO) vessels – which may provide opportunities for companies in the tanker sector.

By Myles Mantle (partner), Teena Grewal (Counsel) and Danielli Pugliese (Associate), Haynes and Boone LLP, UK.

The global market for floating production, storage and offloading vessels (FPSOs) is recovering well from deep lows in 2015/2016 and is expected to perform very well, at least for the mid-term.

Contracts for as many as 24 FPSOs are expected to be awarded worldwide in 2020, 7 of which are expected to be in Brazil.

The remainder of the contracts are expected to be in other Latin America countries (5), Asia (4), West Africa (3), Europe (3) and Australia (2), according to a report published in August 2019 by Rystad Energy, an energy consultancy and business intelligence data firm.

Over the next five years, predictions are for orders of up to 67 floating units.

Expectations are for Brazil to keep first place with planned or announced awards for 21 FPSOs (to be deployed primarily by Petrobras), followed by FPSOs to be deployed offshore Angola (5), Nigeria and UK (4 each) and Norway (2), among others, according to a 2019-2025 global FPSO industry outlook report published by GlobalData, a data analytics and consulting company.

Myles Mantle, Partner, Haynes and Boone LLP.

Danielli Pugliese, Associate, Haynes and Boone LLP.

Brazil

For offshore areas characterized by rough weather, substantial water depths and a lack of existing subsea infrastructure, FPSOs represent an obvious "solution" to the problem of ensuring safe and continuous oilfield production.

This is a particularly important factor for the Brazilian offshore market where the majority of fields proposed to be developed over the next 5 years or so are very far from shore and in deep and ultradeep waters.

In late 2019, Brazil's oil giant Petrobras announced its plans to install at least 5 FPSOs to exploit surplus volumes from the Buzios pre-salt field in the Santos Basin, offshore Brazil and deploying one additional large FPSO per year in the field starting in 2024.

This is an example of the exciting scenario in Brazil, which is expected to account for almost 30% of all global contract awards for FPSOs in 2020 and many more FPSOs deployed throughout the next decade, a combination of several factors leading to an increasing five-year outlook of Brazil's competitiveness score, according to an IHS Markit presentation held in late 2019, amongst others.

In particular

- Substantial oil discoveries in pre-salt fields offshore Brazil, driven to a large extent by Petrobras
- Recent and anticipated bid rounds for new exploration blocks
- International oil companies and more recently independent oil companies prioritizing the country, coupled with the lifting of the requirement for Petrobras to hold at least 30% of the pre-salt fields
- Policies including the extension of the Repetro special customs duty regime and the relaxation of its local content regulations
- The recovery from the country's political turmoil and the Carwash corruption scandal.

Outside Brazil

Further demand is expected elsewhere around the globe.

In the UK, 2 of the projects sanctioned in the North Sea in 2018 will require the development of new-build FPSOs and looking forward some of the larger North Sea projects are expected to use FPSOs.

In Norway, where awards for at least 3 floating production vessels are projected until 2025, there may be further demand in the Barents Sea, where Equinor has already ordered its largest ever FPSO.

There are also great prospects in West

Africa, particularly in Angola and Nigeria, in the Eastern Mediterranean with the development of the Leviathan field in Israel and in South East Asia, particularly in Malaysia, where gas condensate and oil separation and processing facilities may be required.

Gas processing

An intriguing source of new orders to watch is the potential use of gas processing FPSOs lined up next to a liquefaction vessel.

Fitting both processing and liquefaction capabilities on the same platform can be prohibitively expensive and so floating LNG solutions could be better achieved by having a separate processing FPSO and liquefaction platform.

This could potentially increase demand for FPSOs in stranded gas fields which lack gas pipeline infrastructure and where there is not enough gas to justify huge multi-billion dollar FLNG platforms.

Challenges

To meet such a growing demand presents some challenges.

Firstly, financial market regulatory

Teena Grewal, Counsel, Haynes and Boone LLP.

requirements and decarbonization initiatives in society are impacting the availability of capital from commercial banks, and this will be particularly acute with respect to crude processing and production with maybe less pressure on gas processing FPSOs (at least in the medium term).

Banks need to consider how much risk they are willing to take on FPSO projects and for a particular region compared to other energy projects and thus financing is likely to be provided from a wider range of sources in the future.

Secondly, there are environmental concerns in frontier markets (both the difficulties of getting the relevant licences in a previously unexplored area and public pressure to keep those areas intact).

Thirdly, aggressive timetables for the construction of FPSOs and achievement of First Oil present a technical and commercial challenge.

In Brazil, for instance, Petrobras has an ambitious plan to reduce the period between discovery of hydrocarbons and first oil to 1000 days as opposed to a current market average of 1,900 days.

This puts extra pressure on owners to ensure a safe, technically robust FPSO is contracted, financed, designed, built and delivered in a shorter time frame and within budget. This type of pressure has led some owners and operators to propose standardised hull and topside designs.

Despite some challenges, the global market for FPSOs offers exciting opportunities for players in the market.

HullWiper – hull underwater cleaning by robot

Hull robot underwater cleaning company HullWiper Ltd reports a big growth in use of its technology, as an alternative to underwater divers, to remove marine biofouling from ship hulls

HullWiper, a company providing underwater robots for cleaning ship hulls of fouling reports a big growth in take-up of the technology, which provides a lower cost alternative to human divers.

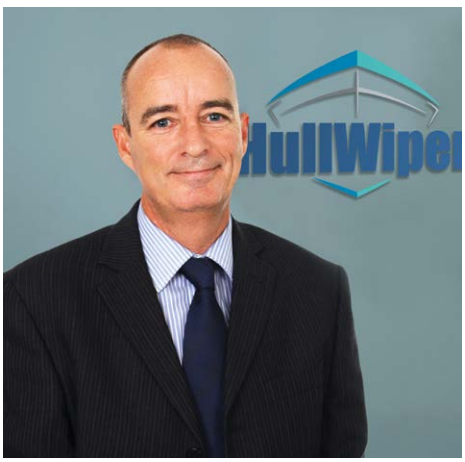
HullWiper is currently rolling the service out in ports around the world.

Looking only at the cost per square metre of hull cleaning, the technology appears initially more expensive than traditional hull cleaning methods such as divers with brushes, which the company roughly estimates to be around $3/m2 compared to $1/ m2 with a diver, this includes attendance by two scuba divers with a wire hand brush so is subjective.

But HullWiper's cleaning method, with high pressure seawater jets, is less likely to damage the hull than divers using brushes, and so extends periods between cleaning and it works out cheaper overall, the company says.

No harsh chemicals, scrubbing or abrasive materials are used.

"For a vessel with a typical five-year paint plan, hull cleaning with divers/brushes shortens the life of the coating by eight months (or 80u roughness) per clean," says Simon Doran, managing director of HullWiper.



HullWiper Managing director, Simon Doran

"This paint damage increases the roughness on the ship hull and therefore the drag, but also increases the regrowth of the algae due to better foothold."

HullWiper catches, filters and compresses the fouling, which is captured onboard the ROV's unique filter system. The fouling is removed from the robot when it is brought onshore, and disposed of by an approved environmental waste disposal company.

The fouling does not fall into the water risking the spread of harmful invasive species.

It is concerns about pollution from fouling removed from hulls which has led many ports to ban cleaning by human divers while a vessel is in port.

This means that the vessel cannot be cleaned and loaded/unloaded at the same time.

So a vessel must usually be taken 'off hire' while it is being cleaned by divers.

With HullWiper you can clean in the port. Also with HullWiper, you can clean the hull at night time, something which can't be done with divers. And of course it does not need any breaks or rest periods after it has entered the water.

The robot device is known as a "remotely operated vehicle" (ROV), similar to the devices used in oil and gas subsea (seabed) projects.

The ROV is "driven" from an operator on a barge or offshore support vessel. This gives more flexibility than operations from a jetty. If it was operated from a jetty, the work would need to be planned around the vessel's berthing schedule and cargo operations.

Testimonials

Stephan Martinussen, Maersk Line's head of global vessel performance centre, said in a written testimonial on the HullWiper website, "we place a high degree of focus to ensure world class bunker efficiency and thereby reduce our fleet's carbon footprint. Hull performance plays a key role in that objective. It uses technology that is both eco-friendly and facilitates diver free hull cleaning of our vessels."

Jesper D Rasmussen, a former managing director of Maestro Technical Shipmanagement, provided a written testimonial saying it was a "very good initiative", and aligned with "the way environmental legislation as well as bunkering are going. Hull cleaning is clearly going to be one of the ways of saving a dollar on fuel consumption".

Online calculator

Having a clean hull improves a vessels speed, or enables it to operate at the same speed with less fuel consumption (and so less CO2).

There is an online calculator on the HullWiper website, which will tell you how much it thinks a HullWiper clean will save on your next voyage, taking into account the type of vessel, vessel size, engine type and power, voyage information, chartering rate and fuel type (and so fuel cost).

It will calculate the hull area, how much HullWiper will cost, how much conventional cleaning will cost with divers, and additional costs from divers, including from having the vessel off hire while the work is being done, and paint damage HullWiper thinks diver cleaning will cause.

It can also estimate how much extra costs you will incur from having a fouled hull, including from extra fuel costs (which worked out at about 4% more, on an example *Tanker Operator* tried). It will estimate additional chartering cost from this speed reduction, calculated by the extra time a fouled ship will take compared to a clean ship (which worked out at about 6% of the fuel cost, on an example *Tanker Operator* tried).

Where it is available

The service was first launched in 2013 in Dubai and has since expanded to include key locations in the Middle East(Port Khalid – Sharjah, Port Rashid - UAE, Fujairah – UAE, Jebel Ali – UAE) as well as ports in Australia (Brisbane, Bundaberg, Gladstone and Townsville), Egypt

Controlling the robot hull cleaner

(Suez Canal), Mauritius (Port Louis), Panama (Balboa), Singapore and Spain (Algeciras). There is a Gothenburg base covering a wide area of Scandinavia - the Sound, Great Belt and Skaw areas; Copenhagen, Malmoe, Kalundborg and Frederica Havn.

The service in Gibraltar is provided by ship fuel conservation and underwater services provider SCAMP. It plans to have a second unit in operation in the first quarter of 2020, following the first unit doing around 60 hull cleans over 2018-2019.

HullWiper will offer the service in Ras Laffan, Qatar, from early 2020, in a partnership with GAC Qatar, which has a license from the country's Environment Ministry.

Plans are in the pipeline for new locations including Sri Lanka, Korea, South Africa, Chile and Bahamas.

It is approved to work with coatings from Chugoku Marine Paints, Hempel, International Paints, Jotun, PPG Protective and Marine Coatings, SeaCoat Technology. "These coating manufacturers approve of our ROV methodology and cleaning process," Mr Doran says.

The company has a leasing program to provide the technology to service providers, where HullWiper does not have its own base, interested in offering it to their clients.

Simon Doran

HullWiper's Managing Director Simon Doran is a former diver with the Royal Navy, who has also served with the UK army in the Falklands, Northern Ireland and Operation Desert Storm.

As a former diver, Mr Doran says he appreciates how dangerous diving can be.

"I am a diver at heart, and I know that what we do reduces the risk to divers. Hull cleaning can be labour intensive and arduous for a diver at the best of times, and you can imagine the unnecessary risks and even shortcuts that can be taken when a dive team is cleaning a VLCC by night, at anchorage."

"Whilst there are a number of first class diving companies who work to the highest standards with correct equipment, there are still Mickey Mouse outfits that choose to ignore what it means to be a professional commercial diver."

www.hullwiper.co

TO

Options for CO2 cutting fuels

Reducing CO2 from vessel operations through performance improvements only gets you so far on CO2 – in due course, shipping companies will need to consider options for different fuels. ABS considers three options - light gas (LNG / hydrogen), heavier (LPG / methanol), and liquids (bio/synthetics)

By Georgios Plevrakis, Director of Global Sustainability, ABS

The shipping industry is being challenged daily by the need to improve its environmental performance and reduce its contribution to climate change.

The debate is welcome, but the result is often a welter of competing voices discussing solutions that are still far from commercial availability.

Rather less attention is paid to what owners can do in the shorter term to begin to manage the transition to a carbon neutral future.

This confusion is more than theoretical; a situation in which owners weigh their options for the future risks a slowdown in newbuildings at a time when new orders are already close to historical lows.

Although the IMO will announce its final decision for the implementation of the 2030 and 2050 carbon reduction deadlines by 2023, there are several facts that are already known.

There will be no 'cheap fuel' in future. The IMO 2020 regulation has begun this process, but the industry needs to accept that carbon neutral and zero carbon fuels could be two to three times more expensive than those currently used.

The technical developments for producing the fuels that shipping needs are still in progress, however, the industry has some options to begin reducing carbon. Choices which fall into pathways that will ultimately bring them to sustainability.

The vessel type and trade pattern will play a significant role in determining the choice of pathway to sustainability; different fuels suit different vessel applications, whether large or small, coastal or deepsea.

As such ABS is fuel and technology agnostic; we are working with owners and shipyards to identify the right path for their specific vessels and business case to deliver safe, practical, and simple solutions.

Three pathways

ABS has identified three fuel pathways potentially open to shipping.

The first can be defined as 'LNG or light gas', using generally light, small molecule fuels with high energy content, but more demanding, mainly cryogenic fuel supply systems and storage. This group includes the relatively mature methane (as LNG) solution leading towards bio-derived or synthetic methane, and ultimately to hydrogen as fuel.

On this pathway, if methane slip is discounted [methane which slips through the engine without combusting], LNG can reduce CO2 emissions by 20 per cent. Bio-methane can be carbon neutral, while hydrogen is a zero carbon fuel.

Methane slip is starting to receive detailed scrutiny and though is not at present subject to regulation, this is expected to change in the near future.

As a result, there is intense industry focus on minimizing methane slip. Whether this can be achieved in the context of potential regulatory changes could be a defining factor for the future of LNG as fuel.

Hydrogen can serve as the ultimate solution along this pathway, but it will necessitate significant technical advances, which may require a decade or more, until it becomes a practical solution. Although hydrogen has lower volumetric energy density than methane, it has far higher energy content, almost three times that of LNG and HFO.

The second pathway is defined as 'LPG/ Methanol', by using generally heavier, more complex molecules with lower energy content, but with less demanding fuel supply and storage requirements than the light gas pathway. This group includes LPG, methanol and ethanol, leading to bio-derived or synthetic LPG/methanol and ultimately to ammonia.

The fact that most of these fuels have a lower energy content imposes constraints on the types of vessels, trades, and routes they can be used on, but in their first generation are already mature.

LPG and methanol are parts of the existing technology mix. On this pathway, methanol can reduce CO2 by 10 per cent, while bio-methanol

ABS Director of Global Sustainability, Georgios Plevrakis

can be carbon neutral, and ammonia is a zero carbon fuel.

While ammonia shows considerable promise as a fuel, the technology for its storage and application still needs to be developed, and regulations must account for its particular safety considerations.

The third pathway hinges on bio/synthetic fuels that are derived from renewable sources and can produce liquid fuels.

These fuels have similar properties to diesel oil and thus are much less demanding in terms of new infrastructure and technologies onboard and can be utilized with minimal changes to current ship designs.

Currently, the most widely used bio-derived fuel is biodiesel (also known as FAME). The use of FAME is included in the latest ISO 8217/2017 fuel specification for marine fuel blends, which allows for 7 per cent biodiesel by volume, though some owners are known to be testing richer blends with up to 20 per cent or higher.

First generation, plant-derived biofuels face challenges such as competition with food crops and high carbon intensity during production, but second generation biofuels, such as hydro-treated vegetable oil (HVO), can overcome these challenges while offering similar energy content to MGO.

In the future, a third generation of biofuels, such as lignocellulosic or algae-based fuels could potentially provide the industry with almost 500 million tons of fuels annually, more than the current annual bunker demand. This group includes electro/synthetic Gas-to-Liquid (GTL) fuels produced though either carbon capture and electrolysis, or from converting biomass to syngas and then to liquid fuels such as methanol or diesel.

The main challenge in gas to liquid production is to make it economically attractive. If so, it can produce higher grades of hydrocarbon fuels which can be readily used in the engine, thus requiring the lowest capital investments for the ship of any of the three pathways.

Short term actions

The selection of the most appropriate fuel pathway and related technology is certainly a challenge, which includes considerations of the vessel's size and design, as well as evaluation of whether lower or higher energy content fuels will best match its operational profile.

For owners considering vessel orders in the next five years, the choice is effectively between LNG, methanol and LPG since these will provide a pathway to carbon neutral and ultimately zero carbon fuels. By 2030, owners can expect that the options of carbon neutral fuels will be sufficient to provide them with the required blending capacity.

However, owners can take some steps to future-proof their vessels, starting with designs that assume the greater use of electrical propulsion to reduce the fuel consumption of the vessels. This philosophy assumes that the electricity can be produced from any fuel pathway and can be used for propulsion or power generation onboard, using batteries or fuel cells for full or partial load operation.

Forward-looking owners and charterers are already starting to look at electrical installations, whether to optimize the prime mover or for more efficient generators to minimize the carbon footprint of the vessels. It is already possible to specify a portion of electrical propulsion or specify the layout of the engine room for future retrofitting. The technology is still evolving but evaluating how to use electrical drives that are agnostic of fuel supply can be an effective way to future proof a design.

Conclusions

Decarbonization is a significant challenge, arguably the biggest the industry has ever faced, but it must be addressed; shipowners should not be bystanders in this process and they cannot arrive at the decarbonization targets alone.

By studying future fuels and by considering the degree to which electrical propulsion systems and new energy efficiency technologies will play a role in future, the shipowners can best position themselves in the marketplace.

Our approach is to simplify this complex problem and enable shipowners to make informed decisions about the fuels and systems that are right for their assets and operation.

At ABS, we see our role as a continuum by supporting the industry in understanding the nature of this challenge, helping our members, clients, and other industry stakeholders to assess the emerging landscape and ultimately the regulations with which they must comply.

Most importantly the transition to an era of new fuels must be accomplished safely, with development, testing, and implementation of new fuels along with propulsion systems subject to the same analytical rigour as any previous or existing maritime technology.

Asahi / Mitsui / Mitsubishi's plans for zero emissions tanker

Asahi Tanker, Exeno Yamamizu Corporation, Mitsui OSK Lines and Mitsubishi Corporation announced plans to build the first zero emission tanker by mid-2021.

Asahi Tanker Co., Ltd., Exeno Yamamizu Corporation, Mitsui O.S.K. Lines Ltd., and Mitsubishi Corporation announced an agreement in August 2019 to make a new company "e5 Lab", with a first objective "to build the world's first zero-emission tanker by mid-2021."

The tanker will be a coastal vessel powered by large-capacity batteries and will operate in Tokyo Bay.

The plan was that e5 would consolidate the "technologies, know-how and networks of its four major shareholders."

The companies involved have not released much further information about their plan, but they say that they aim to "leverage this platform to encourage sustainable growth and development within the marine shipping industry."

Other Goals

They have other big goals.

Improving working environments and mitigate crew shortages by upgrading onboard communications systems.

Leveraging sophisticated sensor technologies to improve ship maintenance and management, thereby ensuring that aging vessels can be operated as safely as possible

Leveraging autonomous sailing technologies and big data to provide onshore support for crews and contribute to safe, reliable and efficient ship operations.

Offering an electric-vessel platform to all stakeholders in the marine shipping industry (including shipbuilders, equipment manufacturers, ship owners and operators, and cargo owners), standardize vessels and otherwise help to develop a sustainable growth model within the industry.

Proposing standards on the swift and broader application of next-generation technologies.

Leveraging large-capacity, rechargeable batteries to provide emergency backup power and otherwise assist with the business continuity planning of local communities.

e5 Lab also plans to "actively promote the electrification of both coastal and ocean-going vessels."

It will "pool the technologies, human resources and operational know-how needed to achieve the 50% GHG reduction target of the International Maritime Organization (IMO) as soon as possible."

In December 2019, a further MOU was signed with Japan's Mitsui O.S.K. Lines, Ltd and e5 Lab, to conduct a joint study of a hybrid pure car carrier equipped with a hydrogen fuel cell system and large-capacity batteries.

In the open sea, an LNG fuelled generator would be used to generate power to charge up large capacity batteries.

In November 2019, e5 announced it had signed a memorandum of understanding with SoftBank Corp to "start jointly studying the provision of marine broadband services that utilize next-generation communication satellites."

It would run trials from Jan 2020 to May 2020 with flat antennas onboard vessels. It would run trials from Jan 2021 to end of March 2020 using OneWeb communications satellites.

In October 2019, it announced plans to develop a "concept design" for an electric propulsion harbour tugboat powered by a large capacity battery and hydrogen fuel cell. It would operate in Yokohama and Kawasaki Port, and have 2 x 1500 kW azimuth thrusters for propulsion, giving it 50 tons towing power.

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How 2020 sulphur rules are turning out

One of the biggest concerns brought about by 2020 sulphur rules is unexpected – the availability of traditional fuels at traditional prices. There are also concerns about mixing non compatible fuels and decreased lubricity, writes Neil Graham, technical director of Royston

As 2020 dawns, it appears that suppliers have responded to the upcoming demand for very low and ultra-low sulphur heavy fuel oil, and supply will not be a problem.

Possibly of greater concern is how long high sulphur heavy fuel oil will remain available. Or if the price of it will get closer to the low sulphur fuels. If this happens, it will greatly affect the ROI of those owners who opted for scrubbers.

Another problem could be incompatibility of bunker stems (individual deliveries).

The nature and type of fuel oils that will be available are expected to differ significantly.

The mixing of non-compatible fuels can lead to the formation of sediment in the tanks which can block filters and purifiers.

This may leave shipowners facing serious engine repairs, requiring vessels to be taken out of service.

Practical steps need to be taken to secure quality control. Industry good practice proposes developing a 'bunker checklist' to supplement the vessel's own safety management system procedures – a list of checks and tasks from pre-bunkering through bunkering to final completion and disconnection.

Fuel segregation between bunker sources will also become a feature of future operations until all sources of fuel can be proven to be stable, mixable and compatible with each other.

Smaller bunker orders may become the order of the day to avoid mixing different fuel supplies.

Monitoring of the fuel will be increasingly important to avoid poor quality fuel reaching the engine, as well as running purifiers at their optimum settings i.e. the right fuel oil temperature and the correct throughput (slow as possible).

Neil Graham, technical director, Royston

Royston engineers doing repair work on marine engines

Decreased lubricity

Lower sulphur content in fuels will contribute to decreased levels of 'lubricity' in engines.

This will contribute to increased wear and tear in fuel pumps and require additional maintenance of injectors. These components have high tolerances.

Most manufacturers of fuel pumps have already moved towards a higher material specification for their plungers and often use a diamond-like carbon (DLC) coating to reduce wear. These coatings are extremely hard, corrosion resistant and have ultra-low coefficients of friction. They can also be deposited with a high-degree of control of the coating thickness.

Cleaning

If the decision is made to move away from high sulphur HFO and scrubbers, the cleaning of pipes and storage tanks will need careful planning and mean substantial costs and down-time.

The recommended best practice is to flush through the system with distillate and afterwards dispose of it as waste oil.

Scrubber

Scrubbers are accepted by flag states as an alternative means to meet the sulphur limit requirement. These scrubbers are designed to remove sulphur oxides from the ship's engine and boiler exhaust gases. A ship fitted with a scrubber can use high sulphur heavy fuel oil since the sulphur oxides emissions will be reduced to a level equivalent to the required fuel oil sulphur limit.

The most likely ships to install scrubbers are the larger deep-sea vessels which have high fuel consumptions and crucially have the space in the engine room to fit this equipment. A 50t / day seems to be an accepted cut-off point for fitting a scrubber and still obtain a reasonable ROI, say within 5 years.

LNG

Converting engines to liquefied natural gas (LNG) will provide considerable reductions in fuel costs as well as reducing emissions, including SOx.

It will first need to be determined if the existing engines can be converted to gas, or if new engines are required (dual fuel or pure gas).

Finding space in the engine room for the storage tanks is key and, depending on whether the engines are converted to dual fuel or pure gas, there may still need to be a liquid fuel storage system as well. TO

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Removing hazardous vapours from tanks using nanotechnology

Ecochlor is providing a technology which removes VOC vapours from fuel and cargo tanks, and suppresses further evapouration from fuel and sludge with a liquid suppressant

Maritime equipment company Ecochlor, headquartered in Maynard, Massachusetts, is providing a service to the maritime industry which promises to clear a tank of VOC (volatile organic compound) vapours in a fraction of the time that air purging or gas inerting requires.

Fuel and cargo tanks contain hazardous VOC vapours, especially when sludge is present in the bottom of the tank.

VOC vapours must be managed for several reasons. They have to be removed before filling the tank with a different cargo. They carry a risk of explosion, when mixed with oxygen in the right ratio. They must also be reduced to a safe level for any person to enter the tank for inspections or maintenance in order to prevent unhealthy exposure for workers.

VOC vapour management conventionally involves inerting the tank by pumping a non-reactive gas, such as nitrogen, into the tank to displace oxygen. This removes the explosive hazard but means a worker cannot safely enter the tank, as breathable atmosphere has been removed.

Ecochlor's new technology is licensed from NanoVapour Inc, based in the Woodlands, Texas. It utilizes a liquid suppressant which is blown into the tank together with compressed air, creating extremely small "nano" droplets. The nano droplets work at a liquid surface level, creating a molecular layer that quickly suppress any VOC vapour formation in the tank, as well as preventing further evapouration without removing breathable atmosphere. This allows workers to safely enter the tank without risk of asphyxiation or explosion.

A container of liquid suppressant

The portable delivery unit

While the technology is new, "it is important to use standard sensors to measure VOC vapour in the tank, and determine that the technology has worked as described", says Andrew Marshall, Vice President, Business Development, Ecochlor.

According to Mr Marshall, "The NanoVapour method can be up to 90 per cent faster than using normal air ventilation," as well as better for the environment. "This nanotechnology is completely non-toxic, non-corrosive, non-reactive, and biodegradable. It is completely safe for human contact."

Other tank inerting technologies, such as filling the tank with water to suppress and remove VOCs, also create a waste disposal challenge. According to Ecochlor, NanoVapour leaves no waste to clean up or contaminate the environment.

Shell Oil conducted a study in which compared NanoVapour to all possible alternatives for removing VOC vapour from petrol underground storage tanks, such as air purging, water filling, inerting with nitrogen, and dry ice (CO2). Upon completion, Shell chose NanoVapour as their "global best practice" for fuel storage tank degassing for maintenance and inspections.

Ecochlor is the exclusive marine agent for the product.

About the technology

The technology was initially developed for use in aviation, where VOC vapours must also be removed from a fuel tank in the course of maintenance. Since development, it has been utilized in tanks at retail petrol (gas) stations.

It has been optimised for hydrocarbons categorised as C5 or heavier, including gasoline, diesel, jet fuel and heavy fuel oil.

The technology comprises a container of liquid suppressant, and a portable hardware delivery unit which blows the nano droplets into the tank using compressed air. The system weighs only 45kg, is about the size of a filing cabinet, and has no moving parts. It is connected to a compressed air input, and the output is connected to the tank vent. The delivery unit will use about 1 litre of liquid suppressant per hour.

There are a number of demonstration videos on the Ecochlor website, including using the fluid above an open container of petrol, and then lighting a match above the petrol to see that there is no VOC igniting.

In December 2019, NanoVapour received a product type approval certificate from Lloyd's Register.

Using in practice

The shipowner takes out a contract with Ecochlor to use the NanoVapour technology.

Ecochlor also provides a chemical related service for ballast water treatment, and in that, there is a requirement for an Ecochlor technician to visit the ship twice a year, and can do chemical resupply at the same time. The same ship visit can be used to replenish the NanoVapour suppressant.

It will be initially available for use in bunker tanks, and towards the second half of 2020 the company plans to look at cargo tank applications.

The technology has not yet been extensively used in the maritime sector, although if it is reliable enough for aviation, the maritime sector ought to be comfortable with it, Mr Marshall says.

"We're building our body of knowledge on exactly how the system behaves and performs across a variety of applications."

"We want to get to a point where we can give a specific answer to a question like, 'I've got a bunch of suezmaxes, I want to be able to degas, how much and how long,'" he says.

So far, conversations are going on with "a couple of cruise lines, a couple of very large tanker organizations, some Korean bulkers and some Japanese chemical tanker companies," he said.

"If someone wants to take part in those demonstrations they are more than welcome to contact us."

"Beyond that, there's a question of how else we can use this technology. A number of owners that we spoke to have been quite creative in their thinking

"We're adding a process. People have to think slightly differently about how they are doing things onboard. We're taking baby steps to make sure the roll out is done properly."

Enclosed space death

Mr Marshall believes that the technology could also directly reduce the number of enclosed space deaths, one of the biggest causes of death on ships today.

Deaths are often associated with asphyxiation, especially when rescue attempts are made to retrieve an already compromised worker in the enclosed space.

The root cause of these incidents has been attributed by a number of commentators to be time pressure (see Jan-Feb 2020 issue, reports from *Tanker Operator's* Hamburg conference). People do not follow the full procedures for entering an enclosed space because they are also under pressure to get the task completed by a deadline, and feel their job may be at risk.

"It is tough to fix the problem of seafarers feeling under time pressure, but the pressure might be reduced a little if a service like this can make the tank free of gases much faster," Mr Marshall says. TO


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Liferafts which only need servicing every 30 months

Safety equipment company Survitec has developed a liferaft for tankers which only needs servicing every 30 months

Safety equipment company Survivitec has developed an extended service liferaft (ESR) for safe application onboard oil or gas carriers, which allows liferafts to be serviced every 30 months, rather than the 12 months under the servicing model required by SOLAS up until 2009.

The company had to ensure liferafts were hermetically sealed in a water-tight silver foil bag inside an environmentally-controlled container.

To ensure that correct ambient conditions are maintained – a key requirement of the regulation and vital to raft reliability, operability and deployment – the container incorporates humidity and CO2 sensors.

This also means that crews can take humidity and CO2 readings directly from a USB port on the side of the container using a handheld device.

Adopting ESR allows liferafts to be serviced every 30 months, rather than the 12 months under the servicing model required by SOLAS up until 2009, and allows operators to monitor the condition of the liferaft in real-time, says Tommy Scott, head of engineering – Survitec Liferafts.

Tommy Scott, head of engineering, Survitec Liferafts

"From the sensors, crews can take readings once a year to ensure the liferaft is in good working order.

However, to comply with European standards for oil and gas carriers and platforms governed by ATEX (Atmospheric Explodables), we had to create a low powered CO2 sensor to ensure that the use of an electronic device would not ignite or interfere with the ship's cargo."

Polar Code

As part of International Life-saving Appliance Manufacturers' Association (ILAMA) Mr Scott provides input to the IMO working groups involved in establishing safety guidelines and rules and continues to provide input to the IMO Polar Code, the mandatory requirement for the safe ship operation and environmental protection in the polar regions.

"More shipping routes are being developed and so more vessels are transiting Polar waters," says Mr Scott, a Chartered Engineer and a Fellow of the Institute of Mechanical Engineers.

"Special equipment should be carried onboard to ensure that lifesaving appliances (LSA) work as planned. We have been instrumental in providing expertise on the performance of inflatable LSAs in sub-zero

temperatures.

"With average temperatures in the North Pole around -34°C, the essential components on liferafts can freeze, impacting system integrity.

"Equipment such as Survitec's Heating Blanket System have been developed, which wraps around the liferaft container, ensuring this critical system can function in temperatures as low as -70°C."

Ship Design

Mr Scott believes that the robust product design and manufacturing processes Survitec undertakes across its product portfolio is vitally important to maintaining, improving and delivering quality solutions that enhance the users' safety.

"Feedback from customers, suppliers, service engineers, industry groups, research facilities, universities, legislation making activities, search and rescue organisations, training facilities, the whole gamut, is essential," he says.

In the same way, he believes that early consultation with naval architects during the ship design process can maximise a LSA's performance and reduce last minute design changes.

"The vessels in operation today are subject to a vast array of regulations and standards covering every aspect of ship construction and operation. This includes those relating to fire safety measures, such as escape routes, fire protection systems and life-saving appliances and arrangements.

"It is therefore essential to safety that a safety specialist is involved right from the start of the ship design process,"

"The information and knowledge we impart influences policies at both a regional and international level. If we can impact how the industry moves forward and help take safety to the next level, then we are on the right track. After all we are here to save lives," says Mr Scott.

Seagull + Videotel – new CEO and significant investment plans

Maritime e-learning companies Videotel and Seagull have appointed a new CEO and announced plans to invest further in maritime "knowledge and technology"

Maritime e-learning and "knowledge services" companies Videotel and Seagull have appointed a new CEO for both companies, Manish Singh, and announced plans to invest over $30m in new capabilities in maritime "knowledge and technology" over the next five years.

Manish Singh is a former group managing director of corporate development with V.Group and an experienced marine and ship manager himself.

The move follows the acquisition of both companies by private equity company Oakley Capital in May 2019.

The former owner of the Seagull stake was Herkules Private Equity Fund IV, and the former owner of the Videotel was KVH Industries, a maritime satellite communications company.

Oakley has experience in both maritime as well as learning technology businesses. It was previously invested in Headland Media, a provider of media and entertainment services to the offshore and shipping sectors. It has also invested in Inspired, described as "one of the leading global premium schools' groups"; Career Partner Group, "a fast-growing private university" in Germany; Schülerhilfe, Europe's "largest after-school tutoring business"; and AMOS, "one of the leading international business schools" in France.

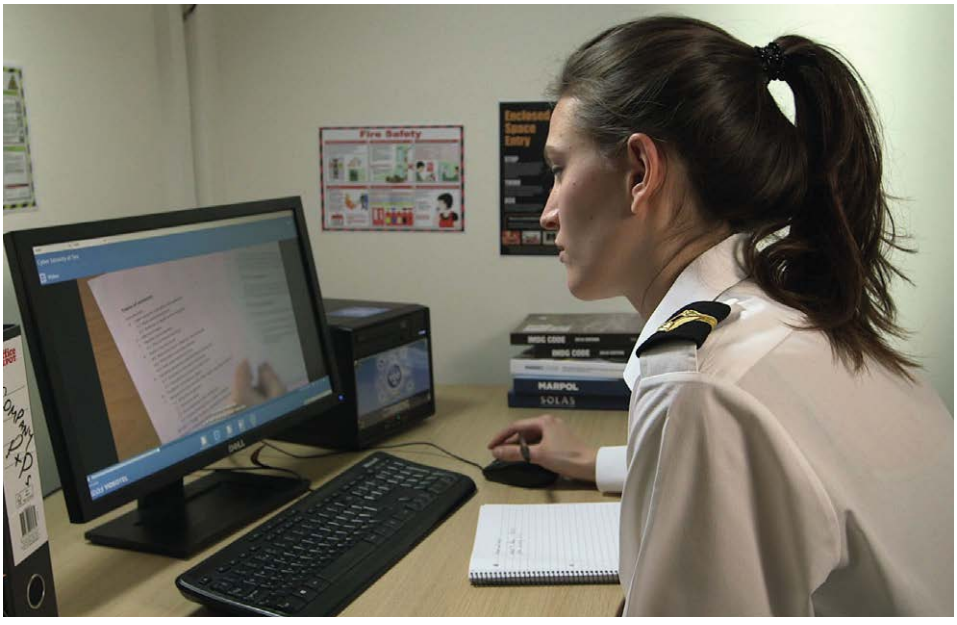
Seagull and Videotel together serve about 20,000 ships and installations and reach about a million seafarers.

In October 2019, Seagull announced it had acquired 50 per cent of the shares of COEX, a software company in Bergen focused on helping maritime companies better manage processes, prove compliance and reduce risk, developing more structured "workflows" to make data easier to manage.

In April 2019, Seagull acquired Tero Marine, a fleet management software company headquartered in Bergen, which makes tools for planned maintenance, procurement and asset management. The company had 55 employees at the time of the acquisition.

One of the ideas behind this acquisition was that it might be possible to combine the planning of ship-board activities, such as operational processes and doing ship maintenance work, with relevant training.

So, for example, a seafarer could be provided with an e-learning package about a piece of machinery he is scheduled to do maintenance work on, if he has never seen it before.



Manish Singh

Manish Singh is a Master Mariner and has over 25 years of maritime experience, of which the last 15 have been in ship management and marine services roles.

Videotel and Seagull CEO, Manish Singh

"I didn't choose the shipping industry, I was kind of born into it," Captain Singh told *Tanker Operator*. "I'm a 3rd generation seafarer, for as long as I can remember I've been around ships. It was always a way of life for me, and subsequently a career I followed in."

"My father is a marine engineer and we have master mariners spanning 3 generations in the family. So, putting Seafarers at the heart of what we do, is fundamental for me"

"As a seafarer, I have been a user of Seagull and Videotel, then as a ship manager a customer of both these businesses" he said.

Private equity

Captain Singh told *Tanker Operator* that values working in a private equity backed environment, something he is familiar with, through his various roles at V.Group, from 2007 to 2019.

"I see private equity as a good agent for investment and change in the maritime services industry," he said. "I think this industry needs blue-chip private equity partners, to help succession and investment into high quality privately owned companies."

When V.Group got GE Capital as its first Private Equity investor, there were very few companies in private equity hands in the maritime sector, now there are over 30," he estimates.

Looking at the background of several blue-chip ship management groups – many were established in the mid-1990s as intensifying regulatory changes following the ISM code made it more compelling for small owners to outsource the management of their own vessels.

As a generation of high quality ship managers faces a period of market consolidation, Private equity companies can help bring the expertise and the capital needed. Also, service companies will continue to need significant investments in emerging technology and develop people with the skills to work with it.

Institutional investors like Private Equity have worked alongside blue-chip private companies and listed corporations, to bring increased transparency and governance in the sector. Commenting on how it is like to work on a Private Equity backed team, Captain Singh says "with a commitment to improve the proposition of the company in their ownership, Private Equity brings more accountability and support to the management," he said. "You understand very clearly what your customers expect from the business and draw on your Private Equity partners to invest in areas that the customers value," he said.

Following the acquisition by Oakley Capital, Seagull and Videotel announced in June 2019 that the company was committing to invest over $30m over the next five years in maritime "knowledge and technology".

This was something Captain Singh particularly wanted to see from shareholders before joining the company. "I wanted to know, what is our shareholders appetite to invest in improvement of the platform, the content, the extension of what the business does – our Value Proposition," he said.

Developing e-learning

The core products of Videotel and Seagull are learning content, approved courses and assessment systems, which come together in the most tested learning management system in the industry.

The combined Group "has the biggest maritime content library in the world by a big margin," Captain Singh says. "However, we want to go beyond Big. We want to work with our customers and other industry stakeholders like OEMs, P&I clubs. Flag Administrations and other Industry bodies – to ensure content is as engaging and as topical as possible."

Captain Singh and team are investing in Virtual Reality (VR) and Augmented Reality (AR) to provide immersive learning experiences which would otherwise involve environments of higher risk, such as entering an enclosed space, navigating through highly congested waters, undertaking wall wash testing on a chemical tanker, or handling a certain emergency situation.

The modules can be taken on their own, in a number of short bites or in a longer session, or as part of a "learning path".

The products aim to be about helping people make intuitive decisions when they do the task on a ship, more than memorising facts. "It goes beyond training, it is more skill development, more intuitive," Captain Singh said. "Our mission is to delivery safety by improving proficiencies and decision making at sea"

The first e-learning applications were designed more about compliance or enabling seafarers to demonstrate a certain level of learning. But now, shipping companies are looking for skills development, above the level required to comply with regulations.

At the same time though, shipping companies are looking for ways to understand the return on investment in training.

Videotel is exploring ways that the training can be more personalised or specific. For example, it could make training specific to a certain ship or fleet, or content specific to a certain original equipment manufacturer (OEM).

Seafarers could be trained to use new equipment before they use it as part of a voyage. This can lead to benefits in both efficiency of operations and safety.

The return on investment can be quantified in other ways. For example, "You might have fuel savings by training the officer of the watch how best to manage the ships operating parameters in a better way," he said. "Better interaction between Seafarers and their operating environment, is where we are going."

Videotel had its roots in being an enabler in communal learning, where a team working onboard and ashore can together experience, discuss and practice how they would deal with an incident, and discuss (or be taught) what a good response looks like.

Image from Videotel's virtual reality training

A further step is simulator based learning, where people develop skills in navigation or managing a vessel engine room, on a full mission simulator.

Simulator based training is a vital part of the blended learning a Seafarer benefits from. Simulator based training requires substantial shore-based investment in infrastructure, risks new technologies making recent investments redundant, requires significant time and investment on part of the seafarer and the ship managers/ owners respectively.

"We see the immersive and collaborative learning experience of simulators as highly beneficial. However, we are miniaturizing the simulator experience using virtual reality and augmented reality" Captain Singh says. The miniaturization and lower costs using virtual reality makes it a compelling complementary experience to full mission simulators, which will continue to be used for key exercises involving bridge teams, engine room teams, cargo handling and other specific equipment / operations.

Using VR, we could work with our customers to deliver virtual pre-joining briefings, helping seafarers get to know the ship, before they join.

"Seafarers have a busy life onboard; they want whatever time they are spending in the learning environment to be immersive and engaging," he says.

Seafarers of all ages, but youngsters in particular, are used to consuming content on tablets and smart phones. "We don't want them to go through a training experience that doesn't feel as interactive as they are used to." TO

GreenSteam – fuel efficiency advice from digital models

Danish company GreenSteam builds digital models from historical data which can be used to provide advice to shipping companies about how to adjust speed and other factors to get the best fuel consumption

GreenSteam, a marine data intelligence company with offices in Denmark, the UK, and Poland, offers a service to build digital models of how a specific vessel's fuel consumption changes based on different parameters. This model can be used to give advice to seafarers about how to adjust speed or trim and when to clean the hull for optimum fuel consumption.

The company is majority owned by BP Castrol.

The software "ingests" all of the relevant available data about the ship to build the model, distilling large amounts of data into something manageable.

Typically it needs 3 months of data to build the model, so it has data about the vessel's performance in a range of sea conditions.

Currently there are about 500 vessels on GreenSteam's platform. Half of those vessels just send noon day report data, showing the fuel consumption every over the past 24 hours, says Simon Whitford, COO of GreenSteam.

It also integrates the 24h data with high frequency AIS data and meteorological data describing the sea state, wave height, sea surface temperature, for each point of the ocean at different times during the vessel's operation.

For the most sophisticated vessels deploying GreenSteam's dynamic trim optimiser, wave height can be measured with a radar device on the bridge wing, which is more accurate than hull-mounted pressure sensors.

In this way, GreenSteam builds a model of the vessel's performance at 10 minute intervals. GreenSteam also has many vessels which automatically collect high frequency data direct from sensors – the key is being able to encompass every ship regardless of the number of sensors or the frequency of data collection – that is GreenSteam's design principle.

That said, "the quality of the model ultimately depends on the quality and frequency of the data you have," Mr Whitford says.

Many vessels have torque meters measuring the force to rotate the shaft, taken from a sensor in the shaft. This can be used to improve the model. "We gather the data whenever we can get it," he says.

Around 70 per cent of a vessel's fuel consumption is unavoidable – what a perfectly optimised vessel on the calmest of seas would consume. A further 15 per cent of consumption is the vessel overcoming the impact of the waves and wind, and the last 15 per cent is down to vessel optimisation - the impact of fouling and trim (how the vessel sits in the water, whether the bow or stern are higher) and the speed of the vessel.

"It is a very tricky computational task to work out how fuel consumption is affected by speed or trim when these are just 2 of around 13 factors affecting the vessel which are in constant flux but splitting up or as we say, decomposing these various factors with accuracy is unavoidable to competently target vessel performance optimisation." Mr Whitford says.

The model continually evolves as data is added.

"It ingests data, and keeps trying to find correlations, which get better over time," he says. "After a reasonable period of study – looking at the vessel's performance in many different sea states and operating parameters you get a very accurate vessel specific picture."

"For example, when it has enough data, the model has calibrated how each of the 13 factors drive vessel fuel consumption, even when (of course) there are all changing at the same time – that is why we need machine learning."

Simon Whitford, COO, GreenSteam

Return on investment

Mr Whitford believes that its customers usually see a 5 x return on investment, based on the cost of subscribing to GreenSteam, and the fuel savings they achieve.

"If you are already getting data from a vessel, you don't need to make any further capital investment to use the service, you just need to start to share your data with GreenSteam."

In the past, one of the hardest tasks has been to persuade people to act on

the insights that the model provides, particularly when it challenges some strongly held beliefs.

Fuel level data

The most critical piece of information is the vessel's fuel consumption.

GreenSteam is currently developing a mobile phone app which seafarers can use to easily capture fuel consumption data from the vessel and send ashore.

The app turns manual gauge data into a few kilobytes of data – which can either be sent immediately to shore, or incorporated into the noon day report.

The app avoids manual reading / recording errors and timestamps consumption levels automatically.

The project is still in the testing phase. "We've tried it on 10 different variants of fuel gauge so far, at 3 major shipping companies," Mr Whitford says. "Some of the gauges are dirty, we want to prove that it's a robust solution."

It can also be used to reduce intentional and unintentional misreading of the fuel gauge.

Trim advice

GreenSteam's trim optimiser can advise the seafarer how the trim could be adjusted to get the best fuel consumption.

Trim can be described as the "slant" of the vessel – whether the stern is sitting higher than the bow of the ship in the water, or the opposite.

The trim can be measured on the ship either using a "trim sensor", which compares the water pressure beneath the bow and beneath the stern or with sensor equipment mounted in the vessel.

In some vessels, the trim of the vessel can be automatically adjusted from the bridge, by shifting ballast water fore or aft.

GreenSteam is able to train its vessel specific model to learn how the fuel consumption varies with different trim, also taking into consideration the loading of the vessel (and so the draft).

There is a "pre-departure" trim planner, which can calculate the best trim for the specific vessel before you depart, based on the draft (cargo loading) and vessel speed.

GreenSteam has also developed a system somewhat akin to autonomous vehicle technology which, when deployed onboard captures high frequency performance data and integrates this with the vessel's digital model to continually assess the most optimal trim for the vessel – this is called "dynamic trim optimiser". The vessel's trim is adjusted during the voyage, by transferring ballast fore and aft from the bridge.

GreenSteam's trim optimiser – advice on how to adjust trim to get best fuel consumption

The master has a visual display showing whether the vessel is in the "green" or "red" zone, empowering the vessel to optimise each voyage in near real time.

Better alerting

GreenSteam's software generates a range of "alerts" direct to the vessel in near real time. A basic alert might inform the vessel crew that the last 6 hours average fuel consumption has strayed outside an expected range. It can be sent to the captain as an e-mail, with a link to see further insights. "We call those regular alerts," Mr Whitfield says.

Whilst this is useful, the problem with so-called regular alerts is that there may be a simple reason for the higher fuel consumption, such as strong winds. So we risk distracting the "time-starved" crew with too many alerts, sometimes just telling the Captain something he or she already knows.

By the end of 2020, GreenSteam plans to produce "smart alerts".

A "smart alert" would only send an alert to a vessel when there is something useful to say, a specific actionable and useful change they can make.

"For example, it could indicate, "if you were to adjust your speed by this much, or adjust your trim by this much, you can still make your arrival laycan, but you will cut your fuel consumption this much," Mr Whitford explains.

The alerts rely on the latest developments in GreenSteam's machine learning platform and can be configured for the various needs of people in different roles, such as the vessel operator and technical manager.

Longer term decisions

The data in Green steam's models can also be helpful in longer term evaluations such as measuring fuel consumption by exhaust gas scrubbers.

Scrubbers will consume fuel, usually 1-3 per cent of the fuel required for vessel propulsion.

Mr Whitford says that based on his discussions with shipping companies in Greece on a trip held in January 2020, companies can see a price differential between heavy fuel and low sulphur fuel emerging of $350 per ton.

"If you believe this differential will continue for the next decade, and know how much a scrubber will cost to build, you can see whether it would be a good investment."

Can you use drones to inspect tanks?

Inspecting tanks is dangerous, and requires expertise which seafarers don't usually have. Being able to use drones could be a big improvement – in safety and also perhaps supporting better inspections. There are interesting projects in Denmark and Alaska

Inspecting tanks is dangerous, and requires expertise which seafarers don't usually have. Being able to use drones could be a big improvement – in safety and also perhaps supporting better inspections.

We found two interesting projects in Denmark and the US aiming to explore what is possible.

Denmark

In Denmark, the Technical University of Denmark, FORCE Technology, shipping company Dampskibsselskabet NORDEN A/S and Lloyds Register have DKK 11.8m (USD 1.8m) from Innovation Fund Denmark to develop a self-driving drone with "intelligence" for shipping inspections. The total project budget is DKK 19.4m, with the balance paid by project partners.

The project is called "Inspectrone - Autonomous and high-level commanded system for remote inspection of marine vessels to support classification and commercial operations." It was announced in October 2019, and will last for 3 years.

It aims to develop a drone which will use visual sensors (video cameras) and ultrasound detectors. The system is intended to "not require expert users," providing "objective and accurate inspections on its own."

It could be used in enclosed spaces and other hard to access areas.

FORCE Technology, one of the project partners, has a number of years' experience doing drone based inspections.

Lloyd's Register will provide expertise related to structural integrity of ships. Dampskibsselskabet NORDEN A/S will provide its ships for use testing and training the drones. The Technical University of Denmark will develop technology to identify defects in images.

"I am convinced that this technology will be able to give the Danish inspection and Danish shipping industry a leading position on the market, says Evangelos Boukas, Assistant Professor at the Technical University of Denmark.

Cyberhawk

Drone operator Cyberhawk, based in Edinburgh, UK and with an office in Houston, was asked by ConocoPhillips to provide drone based inspections of 12 cargo oil tanks and two slop tanks, on tankers travelling between Alaska and Los Angeles.

In a test, carried out by a two man team, Cyberhawk examined the quality of the entire internal surface of 14 tanks in 7 days.

The US coastguard (USCG) and a class certification body was there to witness the inspection.

Cyberhawk subsequently provided "high quality inspection reports which enabled the client to understand the tank's condition." It can produce a 360 degree digital model of the tank which can be viewed from different levels, including close-up view of areas of interest.

Cyberhawk claims to be the first company ever to complete an internal tank inspection using UAVs, and says it has "worked in multiple environments and projects since the launch of this service.

"This technique allowed Cyberhawk to quickly and efficiently undertake a safe audit of the structure, which in turn meant the client could prioritise further contact inspection or maintenance work," it said.

The data can be examined by someone safely at a desk onshore, rather than being examined by someone onboard.

Cyberhawk now says it is happy to undertake similar internal inspections of large tanks on vessels including FPSOs, bulk carriers and tankers. It usually takes one day per tank to do the inspection, while traditional inspections can take around seven days, the company says.

This survey is normally done by a technique called "rafting", where a tank to be inspected is partially filled with water, and a ship surveyor sits in a raft or dinghy on the water, to inspect areas of the tank which are inaccessible from the tank floor. This creates a large volume of oil contaminated water, which needs to be transferred from the vessel to a waste reception facility.

Using a drone (or UAV) eliminates the need to do this. It also reduces the safety risk to workers.

Conoco Phillips perspective

The client, Conoco Phillips, presented its own perspective.

The traditional method of inspecting a tank could be to build a scaffolding inside the tank, known as "staging", and have surveyors and technicians making a visual survey and taking thickness measurements from the scaffold. This method was developed to meet US Coastguard and American Bureau of Shipping requirements.

Risks include dropping objects on the tank floor, damaging tank coatings, and from people working at height enclosed spaces. It also prevents other work being done at the same time.

Engineering Superintendent John Strebel was project lead for the drone inspection program at ConocoPhillips.

The inspection covered 12 cargo, two slop and five ballast tanks.

Separately, in September 2018, Cyberhawk used three drones to inspect 14 cargo and five ballast tanks on the Polar Resolution tanker at the Sembcorp shipyard in Singapore, in a test project.

Two drones were flown simultaneously, with drone operators on the ship's main deck.

They also used a drone to fly a 36 inch cargo pipeline, a task normally done by a person crawling through it, to look for erosion, damaged valves and overall condition. It entered the pipeline from an access hatch in the cargo tank.

"The results were excellent, providing good clarity for general inspection purposes," Mr Strebel said. TO

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MacGregor – using virtual reality crew training

Bringing the value of expert knowledge closer to customers. The environment is virtual, but the expertise is real; MacGregor's Jan Finckenhagen and Floor Meijs explain how virtual reality crew training can make complex operations safe and efficient.

By Jan Finckenhagen, Training Manager, Offshore Solutions Division, and Floor Meijs, Senior Manager Digital Solutions, MacGregor

Effective crew training is essential within the offshore industry, with some elements being a mandatory requirement and other courses aimed at optimising onboard safety, efficiency and equipment reliability.

However, not all training offers the same capacity for in-depth learning and fully immersive, virtual reality training proving valuable to customers seeking to maximise the operational benefits of MacGregor equipment and systems.

The development of simulation software for mission-critical equipment is undertaken in close liaison with our design and technical departments, which then ensures that training in a virtual environment is as realistic as possible and delivers the intended commercial benefits.

For example, bow-loading system transfer of crude oil between production units and shuttle tankers is environmentally sensitive work and highly regulated.

It is consequently a legal requirement for crew to receive training prior to operating such equipment, even if they have been working at sea for many years.

MacGregor's Jan Finckenhagen

Here lies the advantage for an operator because there is a material difference between conventional classroom-based teaching and virtual reality training.

MacGregor's Floor Meijs

The more realistic the training, the greater the depth of learning.

By undertaking virtual reality training, every possible operational scenario can be simulated, including weather and sea state changes; all mimic operational conditions enough for a participant's brain to perceive that the environment as real, which is key to learning.

Emergency situations which cannot be fully tested onboard can be simulated, as well as maintenance and troubleshooting. This reduces the likelihood of injury or equipment damage because proper operation has been tried and tested in a risk-free environment.

Personnel from different companies, with varying degrees of experience, attend the courses that we facilitate and share their knowledge, which also brings a unique contribution to the training.

Capable crew create additional commercial value

The primary objectives of all virtual reality training programmes are to optimise equipment use, minimise errors and avoidable damage, and enhance service and maintenance capabilities.

Accidents mostly happen because of unfamiliarity with equipment and unpractised routines. Within a virtual environment, crew can quickly and safely gain equipment-specific and operational familiarity prior to going onboard.

MacGregor has established a state-of-the-art training facility in Arendal, Norway which is divided into two zones:

An offshore crane simulator including an operator's chair and portable remote control, which behaves in exactly the same way that it would onboard;

A zone where participants can walk around the simulated ship, familiarising themselves with safe operation of the installed equipment. The use of 'real' equipment in practice exercises provides huge potential for knowledge transfer.

The system software is linked to an advanced simulation platform called 'C-HOW'. Digital copies of equipment are created, and customer-specific operating scenarios and hazardous and unusual situations can all be simulated and trained on.

As part of further progressing the training programme, we are also developing a virtual reality function that can be used for predictive purposes during operation. This uses our extensive operational knowledge to create 'what if' scenarios and the ability to manage them effectively, enabling personnel to make better decisions and execute tasks in an optimal way.

Positive impact on equipment maintenance

Customers gain troubleshooting and maintenance knowledge as a result of their training experiences.

Feedback from customers and our own service departments demonstrates that crew who have attended these courses have improved their operational knowledge to such an extent that they no longer call us for minor troubleshooting and service issues.

With more effective training, the value for the operator is that the crew onboard can repair the things they are supposed to repair, with MacGregor service personnel only travelling to undertake complex tasks where our expertise is used more effectively.

Virtual reality training is a time-efficient way to train crew and establish high safety and efficiency standards prior to the vessel leaving for offshore operation. It can save days, if not weeks, of time in comparison to conventional classroom and onboard training methods, enabling the operator to focus on the vessel's primary purpose whilst at sea.

Building a virtual future

In the future, operators wishing to have more control of their own knowledge and crew training will be able to take advantage of portable virtual reality systems.

We recognise that the most powerful, deep-learning experiences are to be gained through a combination of training opportunities, encompassing immersive sessions in our facility that are then augmented through the use of portable systems in customers' own facilities.

Enormous scope remains to develop virtual reality capabilities even further and we are only just beginning to explore its full potential through interaction with our customers, with requests to do so steadily increasing. TO

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