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Future NET ZERO with the Japan New Technology

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Introduction

The global shipbuilding industry is on the verge of rapid transformation. To address various challenges in the global maritime sector, such as decarbonization and digitalization, Japanese industry is actively engaging in developing innovative ship designs, structures and machineries. In addition, the industry is collaboratively working to achieve the International Maritime Organization's (IMO) target for 2050, 'NET ZERO', through efforts for decarbonization such as adoption of new fuels.

Shipbuilding in Japan 2024 focuses on initiatives by Japanese shipbuilding, shipping companies and marine equipment suppliers to demonstrate their comprehensive technological capabilities in line with the global maritime industry's pursuit of 'decarbonization', with aim to shed light on Japan's shipbuilding industry's current state in achieving 'NET ZERO' from different perspectives. The features in this brochure are expected to serve as a valuable reference for the audience.

NET ZERO
SHIPBUILDING IN JAPAN
2024

Supported by THE NIPPON FOUNDATION

To help manufacturers develop and realise new products, Japan Ship Machinery and Equipment Association has received support from the Nippon Foundation and is now providing business assistance to them.

Zero Emission Ships Project led by The Nippon Foundation

Three consortia to develop future ships with zero greenhouse gas emissions

"HANARIA" is the most advanced in the project and it was launched in September 2023.
©The Nippon Foundation

To achieve carbon neutrality in Japan's coastal shipping sector by 2050, the Nippon Foundation is promoting the development of hydrogen-fueled zero-emission ships, positioning Japan ahead of the global curve. The increasing demand for hydrogen as the ultimate clean energy source, emitting no CO_2 (carbon dioxide) when used, has prompted the Japanese government to designate hydrogen as the ultimate solution for achieving carbon neutrality. Currently, three consortia, involving shipyards, marine equipment manufacturers, and shipping companies, are actively engaged in advancing the practical application of hydrogen-fueled ships. All three consortia have secured grants from the Nippon Foundation, with demonstration tests of fuel-cell ships already scheduled for 2024.

Mr. Tetsuya Kikyo, Program Director, Ocean and Maritime Division, Ocean Affairs Department of the Nippon Foundation, stated, "The Nippon Foundation aims to create something 30 years into the future, formulate rules, and expand the market."

"Ammonia is also being considered as a next-generation fuel, but when ammonia is produced by the Haber-Bosch process, not only is CO_2 produced, but nitrous oxide (N_2O) is emitted during combustion. Therefore, we focused on hydrogen as a completely CO_2-free fuel and launched a project for completely zero-emission vessels," added Mr. Kikyo.

The "Hydrogen Fuel Cell Offshore Wind Turbine Work Vessel Consortium" is developing the world's first offshore wind turbine work vessel utilizing hydrogen fuel cells and biodiesel. The representative company is MOTENA-Sea, a subsidiary of the MOL Group's MOL Techno-trade, and the hull is under construction by Hongawara Ship Yard (Fukuyama City, Hiroshima Prefecture). It is the most advanced in the project and was launched in September 2023 and named "HANARIA". With a gross tonnage of 248 tons and a passenger capacity of 100, the vessel is scheduled for completion in March 2024 and will be the first hydrogen fuel cell ship approved by the Ministry of Land, Infrastructure, Transport, and Tourism for medium sized passenger vessels.

As Mr. Kikyo explained, "It is the ship's version of MIRAI, the fuel cell electric vehicle (FCEV) produced by Toyota Motor Corporation". Yanmar Power Technology's marine hydrogen fuel cell system, which will be installed on the stern side of the vessel, was developed utilizing the fuel cell unit of the MIRAI.

HANARIA can operate in either hydrogen fuel or biofuel modes, reducing CO_2 emissions by 53-100% compared to fossil fuels. The cruising time in hydrogen fuel mode, which is a completely zero-emission mode, is approximately 4 h. In addition to being used as a passenger ship for tramp routes and excursions, it can be used in demonstration tests to transport personnel to offshore wind power plants.

Mr. Kikyo said, "Although HANARIA cannot be transferred to offshore wind vessels, there is still not much demand for CTVs (work crew transport vessels) in Japan to begin with. Therefore, we decided to develop it as a passenger ship because if we completely specialised in CTVs, there would be limited usage".

When supplying hydrogen to the fuel cells on HANARIA, the "Cardle" will be transported by trailer from the ENEOS hydrogen stations in Fukuoka Prefecture and hydrogen will be filled in the fuel cells. Although the demonstration experiment aims for zero-emission operation from start to return, fuel cells alone do not have a sufficient cruising range. Therefore, the use of light oil or biofuel is essential for practical

Image of the hull of a large hydrogen engine-capable coastal tanker equipped with a marine hydrogen 4-stroke engine.
©The Nippon Foundation

applications. Hence, hydrogen-mixed combustion engines are envisioned for use in offshore wind turbine work vessels.

The “Consortium for Demonstration and Operation of Zero-Emission Hydrogen-Engine Ships”, in which the shipbuilding company Tsuneishi Holdings Group is a participant, aims to develop hydrogen-fired engines (that use only hydrogen as fuel) and passenger ships equipped with such engines. The representative companies in the consortium include Tsuneishi Craft & Facilities, Kambara Kisen Kaisha, and Japan Hydro, with significant investment from CMB, a major Belgian shipping company.

In the first stage, the Tsuneishi Group consortium plans to develop a hydrogen-mixed combustion engine and install it on a small ship. In the second stage, the consortium aims to commercialize a hydrogen-mixed combustion tugboat, followed by a cruise ship equipped with a hydrogen-fired engine, which is the primary objective of the project.

“With today's technology, the larger the ship, the larger the fuel cells. If this happens, it will be difficult to tell whether the ship is carrying fuel cells or cargo. We have to build an engine to make the power unit more compact,” said Mr. Kikyo.
In July 2021, Japan Hydro completed an aluminium alloy passenger vessel, Hydro Bingo (19 gross tons), equipped with a hydrogen and diesel oil co-firing engine at Tsuneishi C&F. Currently, a tugboat with a hydrogen co-firing engine, built by Tsuneishi Shipbuilding, is under development, with Kambara Kisen and Kambara Tug Marine Services in charge of ship ownership and operational services. Tsuneishi C&F and Tsuneishi Shipbuilding will develop the hull form, while CMB Tech, a CMB technology development subsidiary, and Japan Hydro will handle the hydrogen site development.

Towards 2026, a general passenger ship equipped with a hydrogen-fuelled engine will be constructed. Additionally, the infrastructure for hydrogen fuel supply needs development, with the primary challenge being to ensure safety and bunkering operations in compliance with existing laws.

Mr. Kikyo expressed enthusiasm, stating, "We need to have a hydrogen-fired ship ready in 2024 and 2025, and we have two years to study it, build it, and conduct demonstration tests. We are on the edge of the deadline, but we are striving to be the first in the world, so we are trying to speed things up."

The project "Development and Demonstration of Marine Hydrogen 4-Stroke Engine and Hydrogen Engine Compatible Large Inland Tanker" with Yanmar Power Technology as the representative company aims to develop a system that can convert from fuel oil-fired to hydrogen-fired by retrofitting an existing inland tanker with a hydrogen-only small high-speed engine.

For the demonstration in 2026, a new 3,500 DWT hydrogen engine-capable hybrid electric propulsion coastal tanker will be designed and built, and a hydrogen engine power generation system and hydrogen fuel supply system will be installed on its deck. In addition, the company aims to obtain Approval in Principle (AiP) from the classification society for a vessel capable of carrying a hydrogen engine in the engine room. This prototype will serve as a model for future domestic hydrogen-fueled vessels.
Mr. Kikyo emphasised that the project is specifically focused on achieving zero emissions for domestic vessels. He stated, "The Green Innovation (GI) Fund project of the New Energy and Industrial Technology Development Organization (NEDO) is also developing hydrogen-fired engines, but these are large, low-speed, two-stroke engines. The Nippon Foundation's project targets domestic vessels, so we are developing a four-stroke, high-speed engine."

However, he also highlighted that without ensuring fuel supply, developing hydrogen-fueled vessels and conducting demonstration tests would be futile. Mr. Kikyo commented, "We are aiming to collaborate with the Ministry of Land, Infrastructure, Transport, and Tourism and others to establish rules and address issues related to hydrogen and safety measures. Our goal is to expand the use of hydrogen-fueled ships more widely."

The Nippon Foundation “Fully Autonomous Ships Project” is now Launched as “Stage 2 of MEGURI 2040”

This time, four vessels will be operated remotely from a single Onshore Support Center

As Stage 2 of MEGURI 2040 is launched by the Nippon Foundation, the Fully Autonomous Ships project is now being upgraded in full swing. In this context, major shipping companies, shipbuilding companies are eager to participate in the project, aiming to commercialize fully autonomous ships by 2025.
Furthermore, a mobile onshore support center will be developed, and emergency response to disasters will be verified.

The Nippon Foundation first conducted a demonstration experiment involving five consortia from January to March 2022 as Stage 1 of the project. The “Sea Friend Zero,” a small sightseeing ship, the “Soreiyu” and “Sunflower Shiretoko” large ferries, and the “Mikage”, a coastal container ship, were used to test the “automatic avoidance" of other ships and obstacles (that might cross the ship's course) using onboard computers. The system also automated the delicate maneuvering required for manual operation of the ship, including entering and exiting ports, and was tested in actual sea areas where the vessels operate.

Stage 2 of "MEGURI 2040" will be the practical application of Fully Autonomous Ships and the development of technologies and rules for their social implementation. To achieve this, 51 Japanese companies, including NYK Line, Mitsui O.S.K. Lines, Kawasaki Kisen Kaisha, Mitsubishi Heavy Industries, and Japan Marine United (JMU), as well as NTT Communications and Mitsui Sumitomo Insurance, have joined the "DFFAS+ (Designing the Future of Fully Autonomous Ships Plus)" consortium.

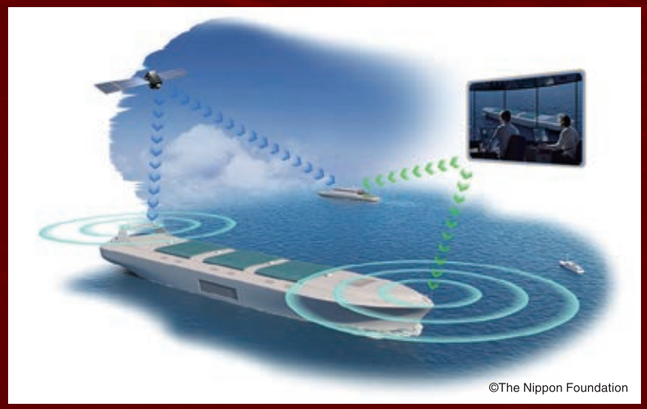
Specifically, the project aims to achieve Level 4 equivalence of fully automated operation, which includes partial capability for fully automated operation. It will develop the following technologies: (1) automated ship operations in congested waters, including avoidance operations; (2) automated ship entering/departing port and mooring; (3) simultaneous support for multiple ships from a distance; and (4) more stable ship-to-shore communication. While developing to achieve these goals, the consortium intends to realize continuous social implementation through deregulation and strengthen international competitiveness through international standardization.

Although only one vessel was remotely supported in Stage 1, in Stage 2, multiple vessels will be controlled simultaneously from a single onshore support center located in Furuno Electric in Nishinomiya City, Hyogo Prefecture, Japan. In addition, a mobile onshore support center will be created to realize the construction of a system capable of emergency response in the event of a disaster.

Four vessels–three existing and one newly built, will be used, and all vessels will be equipped with apparatus compatible with Level 4 automatic operations.
Among these, Ryobi International Ferry's “Olympia Dream Seto” (942 GT) is scheduled to conduct a nine-month demonstration experiment on a regular route (Shin-Okayama Port to Shodoshima-Tosho Port) as a vessel on the remote island route. This will be the first step towards ensuring the stable transportation of people and goods necessary for the lives of remote island residents while creating a mechanism to address the shortage of seafarers, which has become an issue on remote island routes.

The other vessel is the Mikage container ship (749 GT) of Imoto Lines. In the first stage, the vessel was equipped with an Automatic Identification System (AIS) and radar as sensors to detect other vessels, as well as a visible-light camera and an infrared camera for nighttime use. Stage 2 will involve the incorporation of sensors that can monitor a wider area of 360 degrees.

The third vessel is Kawasaki Kinkai Kisen Kaisha's RORO vessel "Hokuren Maru No. 2" (7097 GT), which is planned to operate automatically at a speed of approximately 20 knots (36.5 km/h) in foggy waters with many fishing boats.
The fourth vessel is a new container ship scheduled for delivery in August 2025. Compared to the existing vessels, the new vessel will be equipped with engine plant monitoring and remote support functions, as well as mooring functions. Hence, full-package specifications and functions required for automated operations will be available on the vessel from the start.



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In the future, when automated operations are realized and Fully Autonomous Ships become commonplace, seafarers will be able to work at land-based support centers in various parts of Japan. An increase in the number of onshore assignments will enable them to work as salaried workers, significantly reducing the increased burden due to long periods of time on board and staff shortages.

SHOFU MARU

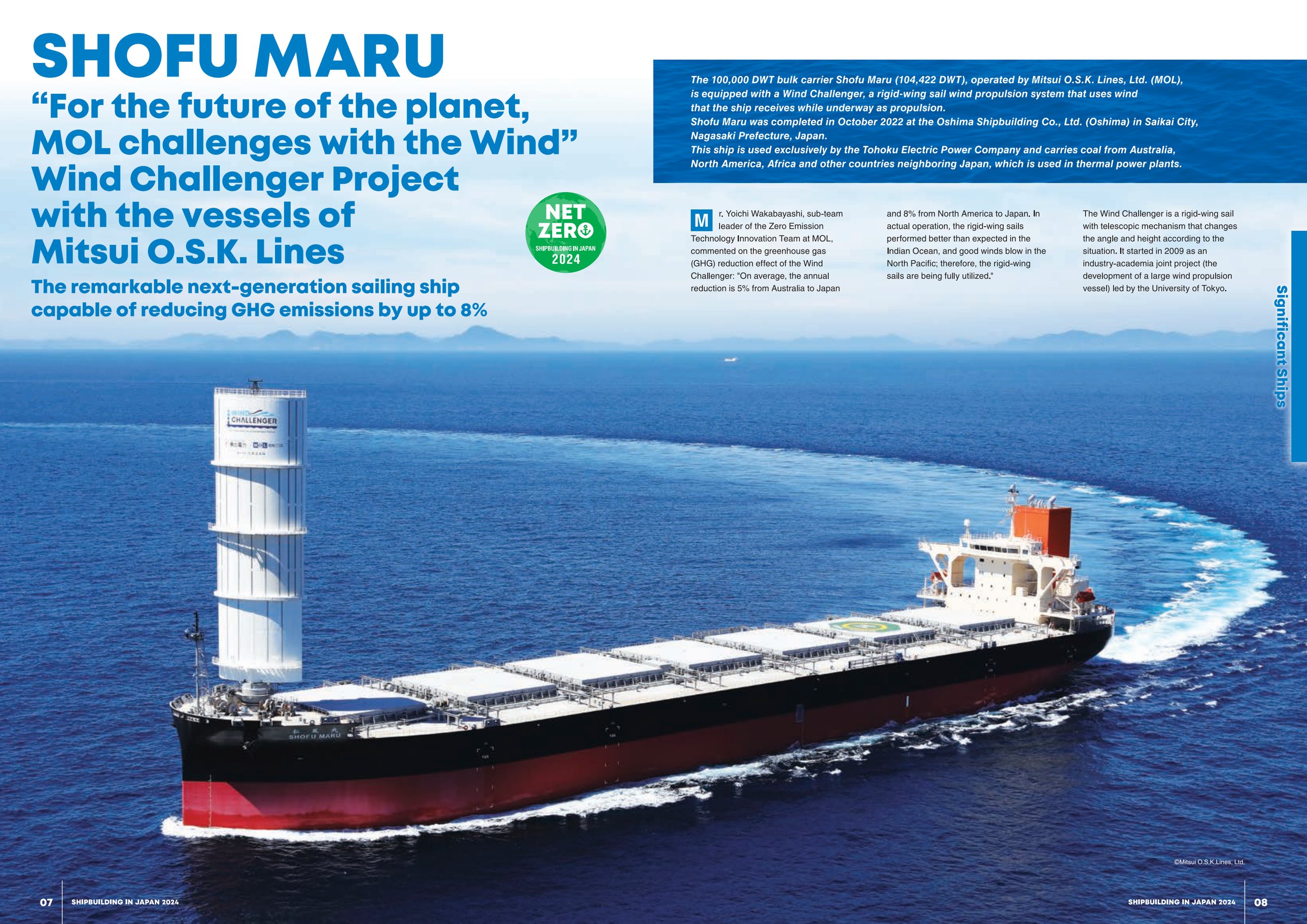
“For the future of the planet, MOL challenges with the Wind” Wind Challenger Project with the vessels of Mitsui O.S.K. Lines

The remarkable next-generation sailing ship capable of reducing GHG emissions by up to 8%

The 100,000 DWT bulk carrier Shofu Maru (104,422 DWT), operated by Mitsui O.S.K. Lines, Ltd. (MOL), is equipped with a Wind Challenger, a rigid-wing sail wind propulsion system that uses wind that the ship receives while underway as propulsion.
Shofu Maru was completed in October 2022 at the Oshima Shipbuilding Co., Ltd. (Oshima) in Saikai City, Nagasaki Prefecture, Japan.
This ship is used exclusively by the Tohoku Electric Power Company and carries coal from Australia, North America, Africa and other countries neighboring Japan, which is used in thermal power plants.

Mr. Yoichi Wakabayashi, sub-team leader of the Zero Emission Technology Innovation Team at MOL, commented on the greenhouse gas (GHG) reduction effect of the Wind Challenger: "On average, the annual reduction is 5% from Australia to Japan and 8% from North America to Japan. In actual operation, the rigid-wing sails performed better than expected in the Indian Ocean, and good winds blow in the North Pacific; therefore, the rigid-wing sails are being fully utilized."

The Wind Challenger is a rigid-wing sail with telescopic mechanism that changes the angle and height according to the situation. It started in 2009 as an industry-academia joint project (the development of a large wind propulsion vessel) led by the University of Tokyo.



Since 2017, the MOL and Oshima have taken over its development as an implementation project and have been working on joint development for installation on bulk carriers.

Mr. Wakabayashi noted that the introduction of alternative fuels is being considered as part of the trend to reduce GHG emissions; however, the type of fuel that will become mainstream in the future remains unknown. The common problem facing alternative fuels, such as hydrogen and ammonia, is that they have a lower calorific value than heavy oil, and regardless of which fuel is adopted, the fuel tank will be large. Because it is important to reduce fuel consumption as much as possible, ships will need to be equipped to cope with any future changes in fuel.

The Shofu Maru was scheduled to be built in November 2020. Tohoku Electric Power Company and MOL signed a contract for the transport of coal by a coal carrier equipped with the Wind Challenger. The maximum height of the sails on the Shofu Maru is 54 m and can be lowered to approximately 22 m. The width is 15 m, which satisfies the viewing angle requirements from the bridge of the 100,000 DWT bulk carrier. To minimize the impact on the cargo-carrying capacity, a lightweight glass fiber-reinforced plastic (GFRP) was adopted as the material for the sails. A lighter weight allows for a larger overall sail area, thus maximizing its use for thrust. The effect on the hull balance was also minimized, thereby enhancing operational safety.

Mr. Yoichi Wakabayashi states that the Wind Challenger combined model is expected to enable NET ZERO in the future.

Furthermore, the Wind Challenger was equipped with an automatic sail control system to maximize the use of wind power. This system uses sensors to detect the strength and direction of the wind, and in addition to rotating the sails, it automatically extends the sails when the wind is light and contracts them when the wind is strong. Conventional sailing vessels require human intervention to adjust the direction and tension of the sails, which requires a high level of knowledge and experience. However, the new system makes it possible for regular crew members to easily perform sailing operations.

The Wind Challenger and Shofu Maru's performance can be checked on board and on land, and a system that can present a calculated eco-friendly route using the wind has also been developed.

“One of our strengths is that we operate our vessels equipped with a Wind Challenger. The data from the operation is fed back to Oshima and based on the knowledge gained, we would like to further improve the system and expand the installation to other types of vessels," says Mr. Wakabayashi.

MOL has decided to install the Wind Challenger on a 62,900 DWT bulk carrier following Shofu Maru, and construction is underway at the Oshima for delivery in 2024. In addition to the Wind Challenger, the ship will be fitted with a rotor sail (cylindrical rotor sail) developed by Anemoi Marine Technologies of the United Kingdom, which is expected to reduce GHG emissions by an average of approximately 20%. The new vessel will be operated by MOL Drybulk Ltd. and transport wood pellets to Enviva, a major wood biomass energy company in the United States.

©Oshima Shipbuilding Co., Ltd.

Shofu Maru

Main features
Overall length = approx. 235m
Overall width = approx. 43m
Deadweight = 104,422 DWT
Port of registry = Noshiro, Japan

Mr. Wakabayashi further commented that the next step after bulkers will be introducing the Wind Challenger to other type of vessels. The challenge is how to satisfy different requirement for each type of vessels. However, the second and subsequent vessels will be developed with different sail designs and control systems to lower the hurdles for introduction.

In the MOL Group Environmental Vision 2.2 announced in April 2023, MOL has set a goal of achieving group-wide net zero emissions by 2050. In this vision, the MOL clearly states its plan to have 90 liquefied natural gas (LNG)-fueled and methanol-fueled vessels with low environmental impact in service by 2030 and introduce 130 net-zero emission vessels and 80 Wind Challenger-equipped vessels by 2035.

The Wind Challenger project is expanding the production capacity and the sail will be installed on three vessels by 2025 and 25 by 2030. Furthermore, MOL plans to develop a next-generation hull form specialized for wind power utilization with multiple Wind Challenger sails after 2035. A 1% reduction in GHGs translates into a 1% reduction in fuel costs. Currently, most of the vessels are running on fuel oil; however, the value of 1% will increase with the use of next-generation fuels such as ammonia, methanol, and hydrogen in the future. Under such circumstances, Mr. Wakabayashi says, “I believe that a ship model that is combined with Wind Challenger will gain more strength on the trend in the future.”

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24,136TEU Container Vessel
“ONE INNOVATION”
delivered on June 2023

©Ocean Network Express(Japan)Ltd.

Japanese largest shipbuilder, Japan Marine United and Imabari Shipbuilding collaborated to build the magenta-coloured Mega Container Vessel operated by ONE

One of the biggest container vessels in the world has been built in the Japanese shipyard. “ONE INNOVATION”, the first of 6 series “Megamax” class, was delivered at Japan Marine United (JMU) Kure Shipyard on June 2, 2023. “ONE INNOVATION” is operated by Ocean Network Express (ONE), the container shipping company headquartered in Singapore. ONE is an organisation that integrates the container businesses of Japan's major shipping companies: NYK Line, Mitsui O.S.K. Lines, and Kawasaki Kisen Kaisha, Ltd.

On December 24, 2020, ONE signed a long-term charter contract with shipowner Shoei Kisen Kaisha for chartering 6 24,000TEU class “Megamax” vessels, which were to be built in JMU and Imabari ShipbuirIding. Two vessels were built at JMU's Kure Shipyard, two at Imabari Shipbuilding's Marugame Headquaters, and two at Imabari Shipbuilding's Saijo Shipyards. In January 2021, The Nihon Shipyard(NSY), was established as joint venture company by Imabari Shipbuilding and JMU, for the purpose of design and sale of merchant vessels, bringing together with various technologies of Japanese leading shipbuilding companies.

The delivery of ONE’s 24,000 TEU class “Meagamax” started with “ONE INNOVATION”, which was built in JMU Kure Shipyard, and ended up with “ONE INTELLIGENCE”, which was built in Imabari Shipbuilding’s Saijo Shipyard, and delivered in December 2023.
“ONE INNOVATION” has the loading capacity of 24,136 TEU(Twenty Equivalent Unit) with 24 rows across. Now, the specific loading capacity of the ONE INNOVATION is 24,136 20-foot container equivalents. The space available for containers on deck provides 24 rows. In the hold (on board), the containers can be stacked in 12 tiers, while on-deck (on deck), the containers can be stacked in up to 13 tiers. The hull size to support this is 399.95 m long and 61.40 m wide, with an air draft of 73.5 m.
“ONE INNOVATION” is also equipped with the unique structure, which is called “bow wind shield” in the bow. This reduces wind resistance to containers on deck from the bow side during navigation, thereby reducing fuel consumption. “ONE INNOVATION” also allows containers to be loaded on top of the mooring deck inside the windshield, improving container loading capacity.
ONE Innovation is also equipped with more than 2,000 reefer plugs in the lashing bridges to accommodate frozen and chilled cargoes, thus allowing ONE to

offer more flexible reefer services in accordance with customer needs.

The bridge instrumentation is also packed with the latest technologies. While various navigational and operational equipment, such as radar, electronic charts, ECDIS, remote control systems for the main engine, have been located separately in the bridge in conventional vessels, seating-type Integrated Navigation System (INS) is installed in “ONE INNOVATION”’s bridge, enabling efficient operation with fewer crews. The INS allows crews to check navigational information and operate the equipment simultaneously without moving around the bridge.

The bridge is an all-weather type, with the left and right wings housed indoors. When the vessel leaves from the berth, it is also possible to maneuver the vessel by using joysticks installed at both ends of the bridge, looking down through the windows on the floor.
The latest electronically controlled 2-stroke diesel engine developed by MAN is deployed as the main engine. The vessel is also equipped with SOX scrubber and AMP (onshore power supply system). AMP allows the vessel to shut down the main engine during the port stay, thus reducing the GHG emissions,

meeting various environmental regulations. As a result, the fuel consumption of this 24,000 TEU “Megamax” class improved by approximately 20% in comparison with the existing ONE’s 20,000 TEU classes. 24,000 TEU class vessels, including “ONE INNOVATION” are deployed on the Asia-Europe “FE3” service operated by THE Alliance. In Asia, the vessel calls at Ningbo and Xiamen in China, Kaohsiung in Taiwan, Singapore, etc. In Europe, it calls at Rotterdam in the Netherlands, Hamburg in Germany, and Antwerp in Belgium. The round trip is 84 days.

ONE commented, ‘As the operator of the 24,000 TEU containerships, we supported the shipowner, Shoei Kisen Kaisha, in formulating specifications to realise various innovations to improve fuel efficiency and reduce environmental impact. We look forward to seeing the performances of these six vessels as the backbone of our fleet.”

Main Features

Main dimensions = Length: 399.95 m /
Width: 61.40 m /
Depth: 33.20 m /
Draft: 16.50 m
Gross tonnage = 235,311 gross tons
Main Engine = 1 MITSUI-MAN-B&W 9G95ME-C10.6 diesel engine
Capacity = 34 Crew
Classification = DNV
Flag= Liberia

“ASUKA”, a Diesel-Battery Hybrid EV Cargo ship

The EV new wave is coming to the maritime industry. An environmentally and crew-friendly hybrid ship is delivered in Japan

NET ZERO
SHIPBUILDING IN JAPAN 2024

©Asahi Tanker Co., Ltd.

The Diesel-Battery Hybrid EV bulk-carrier “ASUKA” (496 gross tons), completed on June 30, 2023, was built by Honda Heavy Industries at its Saiki Shipyard (Saiki, Oita), and delivered to Asahi Tanker (Chiyoda-ku, Tokyo) successfully. The vessel is being long-term chartered to Kamigumi Kaiun, who operates it mainly for transportation of biomass fuel around Kobe port.

“ASUKA” is a prototype of the “Drone SHIP”, a popular hybrid EV bulk-carrier concept developed by e5 Lab and its affiliates Marindows (HQ. Tokyo). It has been designed and system-integrated by Mitsubishi Shipbuilding Co., Ltd. (Yokohama) of the Mitsubishi Heavy Industries Group.

Instead of a diesel main engine, it is equipped with two permanent magnet (PM) motors with an output of 360 kW each as main propulsion. Electricity onboard is supplied by two diesel generators, each 500kW and 440kWh Li Battery, so-called Diesel-Battery Hybrid, which enables navigation with no emission at low speed and for a short while in ports. using a hybrid of a large-capacity storage battery (441 kWh capacity) and a generator, enabling navigation by a battery power feed.

The aft part of hull form is twin-rudder, and twin-skeg wide equipped with two medium-diameter propellers, which increase propulsion efficiency so much in comparison with conventional single shaft drive. One bow thruster, two propellers and two rudders with a maneuvering support function provide superior manoeuvrability that allows berthing even in very narrow channels.

Onboard the vessel, the use of DC microgrids and PM motors has made the engine compartment more compact than that in diesel vessels. The vacant space is utilised for the expansion of crew quarters and additional cargo space.

LiB is charged by diesel generators onboard, also it is possible to be charged from onshore grid when onshore charging system is available. LiB is used during operation in ports enabling complete zero-emission operations. Furthermore LiB is used for peak-shaving of generators load in order to run the generators at most optimum (efficient) condition. Carbon dioxide (CO_2) emissions and fuel costs during operation are expected to be reduced by up to 50% compared with existing vessels.
In the future when practical and reasonable technology comes to the market, it may be able to change generator fuel from diesel oil to alternative fuels, such as hydrogen or ammonia, to make all operations, including navigation, CO_2-free.

NYK Leads the World in Developing "Ammonia-Fueled Vessels"

Achieve zero emissions by 2050 - Promote the development and maintenance of next-generation fuel vessels

©NYK Line.

NYK, which aims to achieve "Net Zero Emissions" globally by 2050, has positioned the development of ships that use ammonia as fuel (which emits no CO_2 when burned), as a "pioneering initiative" for the decarbonisation of shipping, and is promoting its development ahead of the rest of the world. Specifically, NYK plans to develop three new ammonia-fueled ships by 2030, and 12 ships between 2031 and 2033.

The company's development of ammonia-fueled ships is part of the "Development of Next Generation Ships" project, a Green Innovation (GI) Fund project of the New Energy and Industrial Technology Development Organization (NEDO). The GI Fund project was initiated in response to the Japanese government's goal of achieving zero greenhouse gas emissions by 2050. By quickly commercialising ships compatible with next-generation fuels that do not emit CO_2, the aim is to demonstrate to the world the technological capabilities of Japanese shipyards and shipbuilders, thereby leading the standardisation of international rules in the future.

In fact, among several next-generation fuels such as hydrogen and methanol, NYK has focused on ammonia and is developing ammonia fuled tugboats (A-Tug) and ammoniafueled ammonia gas carriers (AFAGC), mainly for ocean-going vessels. The scale of the project amounts to approximately 12.3 billion yen, and the scale of support by the GI Fund is approximately 8.4 billion yen.
At the same time, NYK is also promoting the use of ammonia fuel in domestic vessels.

In the "Development and Operation of Ammonia Fueled Tugboats (Coastal Vessels)" joint project with IHI Power Systems and Class NK, NYK is working on the design and development of a newly designed domestic 4-stroke main engine and an ammonia-fueled vessel that considers safety and practicality.

Additional aims include the establishment of operation and maintenance methods for ammonia-fueled vessels, and the target is to complete construction in 2024. The A-Tug was originally built as Japan's first LNG (liquefied natural gas) fueled tugboat "SAKIGAKE" in August 2015 at the Keihin-Dock Oppama Factory, Yokosuka City, Kanagawa Prefecture. “SAKIGAKE” stands for "pioneer" and represents the spirit of the company's progressive approach to developing next generation-fueled vessels.

Ammonia-related equipment will be installed after February 2024, with delivery scheduled for June. The vessel will continue to operate at the Port of Yokohama, and in addition to its operation, the company plans to establish technology for supplying ammonia fuel for marine use from trucks to ships.

©NYK Line.

IHI Power Systems, which is working on the development of a domestically produced 4-stroke ammonia fuel engine to be installed in A-Tug, has succeeded in conducting firing tests using an actual engine with an ammonia fuel blending ratio of 80% with A-type heavy oil in May 2023. By operating the engine in combination with peripheral equipment, including an after-treatment system for the exhaust gas generated during combustion, the company is striving to reduce the emission of nitrous oxide (N_2O), which has a global warming potential 265 times greater than that of CO_2.

However, ammonia fuel is highly irritating to mucous membrane and can cause serious damage to the airways and lungs within a short period of time. Therefore, NYK is working to ensure that the engine room, where the ammonia-fueled engine is located is inaccessible, and the engine and plant sections are monitored and controlled from separate rooms.

After the SAKIGAKE tugboat is reborn as an A-Tug in 2024, NYK plans to deliver a new ammonia-fueled ammonia gas carrier (AFAGC) in 2026. The development and operation of the AFAGC are being carried out in collaboration with Japanese marine equipment manufacturers Japan Engine Corporation (J-ENG) and IHI Power Systems, and Nihon Shipyard (NSY).

The AFAGC is envisioned to carry ammonia as cargo and use the cargo and ammonia gas vaporised from the cargo as fuel during the voyage. It aims to significantly reduce greenhouse gas (GHG) emissions by achieving an ammonia fuel mixing ratio of up to 95% for the main engines that run the ship, and 80% or more for the auxiliary engines that will run the generators.

To realise AFAGC, NYK and the other companies mentioned above are developing a new ammonia-fueled domestic "2-stroke main engine" and a domestic "4-stroke auxiliary engine" as well as the main vessel, piping systems to handle the ammonia fuel and cargo, and operation sequences for ocean-going vessels. NYK is working diligently to establish on-board safety systems and operation and maintenance methods against ammonia toxicity. In September 2022, NYK received Approval in Principle (AiP) from Class NK.

©NYK Line.

Daihatsu Diesel and MITSUI E&S Contribute to Hydrogen Engine Development

Hydrogen Gas Supply Facility Completed at MITSUI E&S Tamano Factory

Daihatsu Diesel and MITSUI E&S collaborated on the practical application of hydrogen-fuelled engines to achieve zero emissions from ships. In October 2023, a hydrogen gas supply facility capable of supplying large-capacity (1000 Nm³/h) was constructed on the premises of MITSUI E&S's Tamano Factory, and demonstration operations have begun.

The "Technological Development of Hydrogen Fuel Propulsion Plant for Oceangoing Vessels" being promoted by Daihatsu Diesel and MITSUI E&S has been adopted and subsidised by the "Maritime Industry Aggregation and Coordination Promotion Technology Development Support Project " launched by the Ministry of Land, Infrastructure, Transport and Tourism in 2021.
The Ministry has focused on hydrogen as a clean energy source that does not emit greenhouse gases (GHGs) during combustion, and has set the goal of developing hydrogen-fueled engines, fuel tanks, and fuel supply systems, and launching operations of hydrogen-fueled ships by 2030.

In the development of a hydrogen-fuelled propulsion plant, They will obtain the data necessary to determine the combustion cycle of the engine and the optimum conditions for combustion and fuel injection for a large, low-speed, two-stroke marine engine. Additionally, the technology necessary for the design of the fuel supply system will be established.

The hydrogen gas supply facility located at the MITSUI E&S Tamano Factory consists of a liquefied hydrogen tank (47 m³), an evaporator, and a reciprocating compressor. Along with a pressure booster for engines that boosts hydrogen pressure up to 35 MPa and a gas valve train (GVT) that controls the hydrogen supply, the aim is to develop hydrogen combustion technology, establish a coupling operation technology between the fuel supply and large engines, and accelerate the technological development of hydrogen fuel propulsion systems.

The MAN B&W 50 cm bore test engine, installed at MITSUI E&S' Tamano Factory, has four cylinders and the output is 7120 kW. One of these cylinders will be replaced to hydrogen combustion unit for demonstration purposes. Along with a pressure booster for the engine, reciprocating compressors, which form the core of the hydrogen gas supply system, were adopted from KAJI TECHNOLOGY CORPORATION, a subsidiary company of MITSUI E&S.

In October 2023, a high-pressure seal technology in a lubricant-free condition, which was an elemental development, was applied to a reciprocating compressor for a demonstration operation. With the deployment of this sealing technology, it is now possible to satisfy the high-pressure specifications required for compressors in the hydrogen supply chain and They will contribute to the development of hydrogen supply infrastructure.

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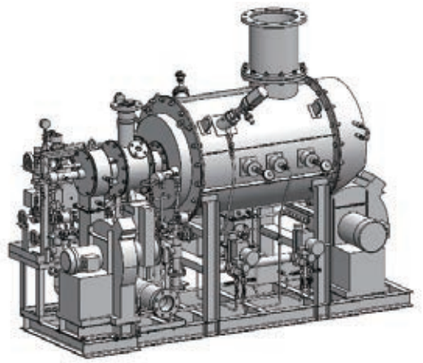
Volcano Develops Gas Combustion Units for Ammonia and Hydrogen Fueled Ships

Safe and proper combustion of ammonia gas from ammonia-fueled ships and hydrogen fuel use contribute to reducing the environmental impact.


Ammonia gas combustion unit MECS-N25
©Volcano Co.,Ltd.

Gas combustion units for ammonia-fueled ships developed by Volcano is one of the answers to the safety issue, and it is also expected to expand the use of hydrogen fuel on board ships.

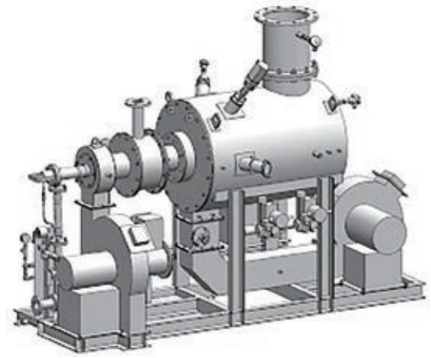
VOLCANO CO., LTD. (head office in Osaka), a marine equipment manufacturer that contributes to environmental impact reduction, on May 25, 2023, launched the MECS-N25 gas combustion unit for ammonia-fueled ships. The product is currently being provided as a carbon-neutral measure for ocean-going ships. Ammonia has attracted attention as a next-generation fuel, and MECS-N25 has the advantage of safely and appropriately burning the ammonia gas generated from ammonia-fueled ships. In addition, Volcano's new MECS-H25 gas combustion unit for hydrogen-fueled ships would make a significant contribution to keeping safe environment.

Toxicity has been an issue in the use of ammonia, but MECS-N25 safely burns ammonia to make it nontoxic, thereby ensuring its safe and reliable use. The ammonia gas treatment and combustion capacity of the unit is typically 70 kg/h. Ammonia gas mixed with an inert gas (N_2 : nitrogen gas), which is emitted when scavenging or loading/unloading fuel into/from tanks, can be used as fuel to reduce ammonia emissions on-board and off-board ships. The company has already commercialized MECS-G for LNG fueled-ships as one of MECS-GCU, which has been used in LNG-fueled tugboats and LNG bunkering (fuel supply) ships and has now commercialised MECS-N25 as an ammonia fuel-compatible version.

The company intends to add other products to its product line-up to accommodate other processing and combustion volumes after monitoring the trend of ammonia-fueled ships, which are expected to become more popular in the future.
Volcano's new MECS-H25 gas combustion unit for hydrogen-fueled ships makes a significant contribution to keeping safe.

Following to adjust the hydrogen-fueled ships projects, the new MECS-H25 will be more potential as one of the MECS-GCU gas combustion units. The MECS-H25 can safely burn the hydrogen gas generated by hydrogen-fueled ships with a hydrogen gas treatment and combustion capacity of 10 kg/h.

These products were created as a new product development grant project by the Japan Marine Equipment Association, with support from the Nippon Foundation. Volcano has commercialized this hydrogen gas combustion unit owing to its own research into the safe combustion processing of hydrogen, which has flammable characteristics, and the establishment of the basic technology.


Hydrogen gas combustion unit MECS-H25
©Volcano Co.,Ltd.

These products are minimum size, Volcano will continuously correspond to larger scale projects.

Supported by 日本財団 THE NIPPON FOUNDATION

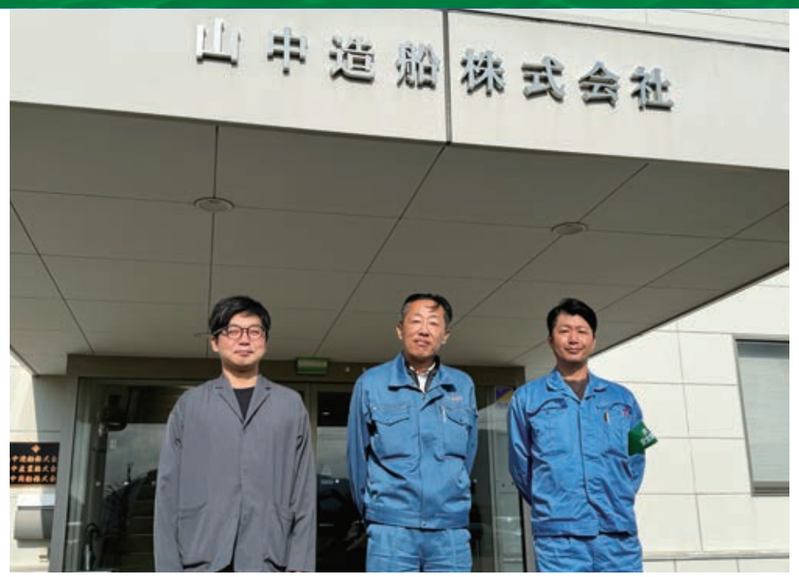
Yamanaka Shipbuilding and SK Winch collaborate to develop electric hatch covers for cargo vessels

Progress Towards Reducing Crew Burden, Reducing Environmental Impact and Resolving Other Operational Issues for Coastal Cargo Ships

©Yamanaka Shipbuilding Co.,Ltd.

Yamanaka Shipbuilding, headquartered in Imabari Oshima island, Japan's largest maritime city, and SK Winch, a local marine equipment manufacturer based in Imabari, have jointly developed and commercialised a motorised hatch cover for domestic cargo ships.
The new hatch cover dramatically solves the problem of crew members being forced to continue using old specifications and existing equipment even if they identify problems in improving the on-board operational efficiency, which is an important issue in domestic vessels.
The project, supported by the Nippon Foundation, has shown positive results in reducing the burdens on seafarers on-board cargo vessels, helping avoid oil leakage accidents, preventing marine pollution, by making the vessels quieter and more efficient because of the use of electric power.

NET ZERO SHIPBUILDING IN JAPAN 2024



In the past, both retractable Elman-type and single-pull hatch covers used hydraulic power as the driving source. However, with the introduction of the improved hatch covers with electric power, it is confirmed that the new system reduces the burden on crew members, improves safety, and reduces environmental impact. The system is designed for cargo ships, which are the most common type of coastal vessels, and can be installed on steel carriers, bulk carriers, and container ships of 299, 499, and 749 gross tons, respectively. The company plans to continue the development and verification of the developed electric hatch cover while installing and demonstrating it on newly built ships and retrofits.

Among the two types of hatch covers, the retractable Elman-type hatch cover is common on steel carriers and bulk carriers, and the single-pull hatch cover folds down individually and is common on container ships. Both hatch covers use hydraulic pressure as the driving source and have the same issues. For example, opening and closing the hatch cover can be dangerous and requires the presence of a person at all times to keep vigilance. The hydraulic equipment and piping on the hatch cover may be at risk of oil leakage accidents from rust due to ageing, and it is difficult for the ship crew to carry out maintenance work on the hydraulic equipment.

Therefore, the company introduced operations that utilised the characteristics of digital control to promote program control and state "visualisation" through electrification and digitalisation. As a result, the burden on crew members was reduced, safety was improved, and maintainability was enhanced using digital sensors to link equipment. By eliminating hydraulic piping, the company was able to solve the root cause of oil leakage accidents.

In the development process, the program was first developed and verified on land in order to electrify the hatch cover. Subsequently, all on-board equipment was connected and tested on land in an environment similar to that of an actual ship. Finally, the equipment was installed on-board the vessel, its operation was verified, and a test run was conducted to simulate a difficult situation.

With technological development, the adoption of electric drive units has realised labour savings and quiet opening and closing. The use of electric cylinders has improved maintainability by eliminating piping. The control panel for the electric hatch cover was installed in the passage next to the hold, thereby effectively utilising dead space on the ship. As piping work was not required, the construction period was shortened. An area sensor was installed on the opposite side of the control panel to prevent accidental opening and closing of the panel in reaction to a person or an object. The control panel was arranged for intuitive operation.

In addition, a remote-control unit was installed in the bridge structure to allow the operation of the electric hatch cover from the bridge. The status monitoring screen displays the speed and torque of the drive and cylinders numerically for "visualisation". In addition, the system has a function to set threshold values for each sequence and issue alarms. The bridge is equipped with several monitors to display information other than that on the hatch cover. The management PC can be connected remotely, allowing remote maintenance from the shore in the case of an emergency.

The company also announced that the developed technology has been adopted in the 499 GT coastal cargo ship "KUNIKI 68" built by Yamanaka Shipbuilding as the first "SIM-SHIP", which is the next generation concept ship developed by the coastal shipping Mirai Research Group. On the ship, the conversion of the retractable Elman-type hatch covers to electric power has also been realized. With the cooperation of Yamanaka Shipbuilding, the winches have also been converted to electric power, achieving hydraulic-free operation. Yamanaka Shipbuilding also introduced a touch panel that can be operated intuitively not only by experienced engineers, but also by new crew members. Additionally, a "status indicator lamp", which was not available previously, was installed to prevent rust and malfunction by covering the lid to protect the equipment. Further improvements have also been made, including the ability to open and close the hatch covers using remote control.

©Yamanaka Shipbuilding Co.,Ltd.

Hence, this is a big step towards more efficient operational performance with a modern bridge with a large number of monitors.

In addition to these effects, the bridge areas have been modernised with numerous monitors. The bridge can now display all types of information on-board the vessel, except for information related to the hatch covers, thereby digitalising shipboard management. In the event of an emergency, instructions can be sent from the shore to the on-board PC, and maintenance can be performed remotely. This system enables smooth coordination between onshore and offshore operations, thereby contributing to safer ship operations.

Supported by THE NIPPON FOUNDATION

Fukui, the global leading manufacture of safety valves for the LNG/LPG carriers and FPSOs

Contributing to the formation of a global infrastructure to achieve carbon neutrality

©FUKUI SEISAKUSHO Co.,Ltd.

Safety valves are normally installed as a final safety device in high-pressure load environments, such as in oil and gas tanks, power generation boiler, and chemical plant piping. When the pressure on the inlet of the valve reaches a predetermined value, the valve disc opens to discharge steam or gas, and closes when the pressure drops to a predetermined value.

In addition to liquefied natural gas (LNG) and liquefied petroleum gas (LPG) carriers, the production of which is increasing to cater to the rising demand for clean energy, Fukui Seisakusho also supplies Floating Production Storage and Offloading system (FPSOs) and FSRU. The global market share of safety valves for LNG carriers is 80-85%. In particular, they have supplied valves to 90% of new buildings since the 1990s and almost 100% of LPG carriers.
According to Mr. Yo Fukui, President of Fukui Seisakusho, the safety valves are essential device for energy infrastructure since any energy production is closely related to temperature and pressure. and Fukui Seisakusho products are essential for transitioning to carbon neutrality.

Fukui Seisakusho, based in Hirakata City, Osaka, develops and manufactures safety valves, which prevent explosions and equipment damage due to pressure build-up (and also flammability) in liquefied gas carriers, and has the largest global-market share of safety valves. Their safety valves are also installed on advanced vessels such as the 'Suiso Frontier', a liquefied hydrogen carrier developed to build a decarbonized supply chain in Japan. This is an example of progression of standardisation in the carbon-neutral field.

Fukui's safety valves, supplied for liquefiedCO_2 Carriers.
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Mr. Yo Fukui suggested the high quality safety valve is integral part for future environmental vessels

In line with the growing international momentum of carbon neutrality, their safety valves have also been adopted in advanced vessels, such as the liquefied hydrogen carrier (Suiso Frontier) and liquefied CO_2 transport test ship (Excool), which were developed in Japan to establish a CO_2-emission-free supply chain. In particular, the Suiso Frontier is required to load, transport and unload liquefied hydrogen at a cryogenic temperature of -253℃, which is 1/800 the volume of gaseous hydrogen.

The accounts, both shore and offshore divisions of Fukui Seisakusho are each half of their total turnover of about 9 billion JPY.
On shore, they have supplied to power generation plants, chemical plants, and oil refineries, among others. In this field, their main business comes from orders through EPC (Engineering, Procurement, and Construction) companies in Japan, such as South Korea and Europe, as well as from auxiliary equipment manufacturers, compressor and pump manufacturers.

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Safety valve in operation

The company has been supplying safety valves for ammonia plants for 20 years. Ammonia is in the limelight as a carbon-free fuel for marine use, and the knowledge gained in the ammonia transportation and production field can be used in the alternative fuel field.

In CO_2 capture and storage (CCS), liquefied CO_2 collected from factories and other sources is transported by ship to a storage site across the sea and encapsulated in a 'reservoir' below ground by 'injection' process. Offshore plants, such as FPSOs and FLNGs, require knowledge and technology between the shore and offshore sides.

Mr. Fukui stated that they are leading the way in carbon neutrality field. Fukui Seisakusho also supplies safety valves for liquefied CO_2 carriers. Furthermore, CCS is key to the production of 'synthetic methane', produced by synthesising hydrogen and CO_2; thus, the sales of safety valves is expected to improve.

Mr. Fukui concludes with the following comment: 'The top companies choose the top suppliers. Standardizations, in which products are developed, disseminated, and standardized at a time when the market has not yet been formed, is manifesting rapidly in the carbon-neutral field also. Against this background, the second and later developments can only be copies of the first. We aim to remain at the heart of the energy sector in a carbon-neutral society'.