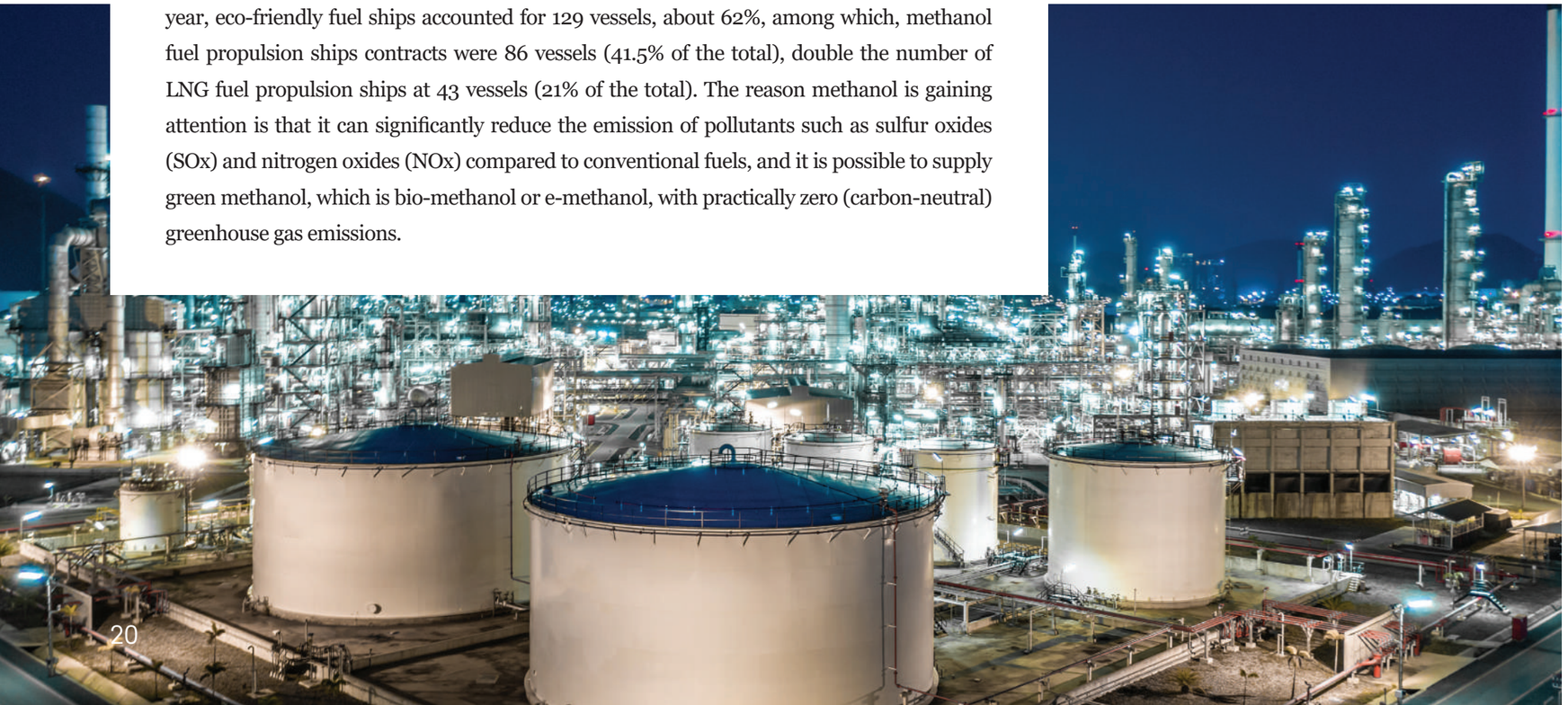
Market and Key Technologies for the conversion to Eco-Friendly Methanol Fueled Container ship

PARK Seungmin, Senior Surveyor of KR Dry Cargo Ship Team

Efforts for Carbon-Neutral and Methanol Fuel

Amidst the increase in greenhouse gas emissions leading to global warming and severe issues like climate change, the International Maritime Organization (IMO) has adopted the '2050 Carbon net-zero target' at 80th MEPC session. As many countries and companies intensify their efforts to achieve carbon-neutral, methanol, along with LNG, is primarily being chosen as an eco-friendly ship fuel at the current time. Especially, according to Clarkson data as of February 5th this year, out of the total 207 newly contracted container ships worldwide last year, eco-friendly fuel ships accounted for 129 vessels, about 62%, among which, methanol fuel propulsion ships contracts were 86 vessels (41.5% of the total), double the number of LNG fuel propulsion ships at 43 vessels (21% of the total). The reason methanol is gaining attention is that it can significantly reduce the emission of pollutants such as sulfur oxides (SOx) and nitrogen oxides (NOx) compared to conventional fuels, and it is possible to supply green methanol, which is bio-methanol or e-methanol, with practically zero (carbon-neutral) greenhouse gas emissions.



Conversion to Methanol Fueled Container Ships

From the shipping company's perspective, converting existing container ships to eco-friendly fuel (Dual Fuel) propulsion involves considering the ease of conversion, scope and cost of conversion, cargo loss, bunkering, etc. Importantly, unlike other eco-friendly fuels, methanol is in a liquid state at room temperature, making it easy to store on ships without the need for cryogenic independent tanks or membrane-type fuel tanks required by LNG, allowing methanol fuel tanks to be integrated into the ship's structure using general structural steel. For this reason, converting operational ships to eco-friendly fuel ships is relatively easier in terms of ship structure and layout when applying methanol fuel. For the conversion to methanol dual-fuel ships, main engines, auxiliary engines, generators, fuel supply systems, and methanol fuel tanks need to be supplied. Depending on the size of the ship, the engines applied, and the capacity of the methanol tanks, about 20% of the cost compared to a new building container ship is required. Additionally, an optimized conversion plan and process work must accompany the effort to retrofit an operating ship.

During conversion, part of the existing container cargo hold (1-2 bays) should be converted into fuel tanks, which can result in up to a 4% loss of existing container cargo for ships over 10K TEU(twenty equivalent unit) class. The stable supply of methanol fuel must also be considered, with currently about 120 million tons produced annually at around 90 production sites worldwide. According to the 『Methanol as a Marin Fuel』 published by KR, the future methanol production market is expected to grow, with current production growth rates indicating that production could increase from 120 million tons in 2025 to 500 million tons by 2050.

Conversion Market for Methanol Fueled Container Ship

Currently, major container shipping companies like Maersk and CMA CGM are increasing the proportion of methanol fuel propulsion container ships through not only new builds but also conversions of part of their existing fleets. In November last year, Maersk contracted with China's Zhoushan Xinya Shipyard for the first project to convert an operational container ship into a methanol dual-fuel propulsion ship. The methanol dual-fuel engine for the conversion is from Germany's Man-Energy Solution, and the targeted ships for conversion are known to be 11 vessels, with the first ship expected to undergo about 3 months of conversion work starting from June this year. CMA CGM has signed a project contract with China's CSSC Group's Qingdao Beihai Shipbuilding for the conversion of 8 operational container ships of 9,200 TEU to methanol duel fuel propulsion. In the future, major container shipping companies including HMM, HAPAG-LLOYD, and SEASPAN are also pushing for methanol duel-fuel propulsion ship conversions, with currently about 70 large operational container ships planned to be converted to methanol dual-fuel propulsion.

Joint Development for the Conversion of a 16,000TEU Large Container Ship

In Korea, 'HD Hyundai Marine Solution (HD HMS)', a comprehensive marine industry solution company of HD Hyundai, has started a business in the field of eco-friendly decarbonized methanol dual-fuel propulsion ship conversion. HD HMS carried out a joint development project (JDP) for methanol fuel propulsion ship conversion with KR, HD Hyundai Heavy Industries (HD HHI), and HD Hyundai Engineering & Technology (HD Hyundai E&T), targeting HMM's largest 16,000 TEU container ship in operation, and obtained basic certification (AIP, Approval In Principle) from KR at the end of 2023.

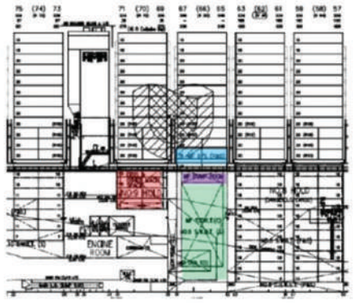
Technologies for Methanol Fuel Propulsion Ship Conversion

HD Hyundai Marine Solution performed the basic design for the system configuration for the conversion of large container ships to methanol fuel propulsion ships, and HD Hyundai ENT was responsible for 3D modeling and detailed design. Additionally, a newly developed 'Low Flashpoint Fuel Supply System (LFSS)' by HD Hyundai Heavy Industries was applied, and the design was based on MAN's main engine and HD Hyundai Heavy Industries' own developed methanol dual-fuel generator engine, the HIMSEN engine. The methanol dual-fuel engine, generator, low flashpoint fuel system, tanks, and cofferdams were designed and arranged in compliance with the IMO's MSC.1/Circ.1621 Interim Guideline.

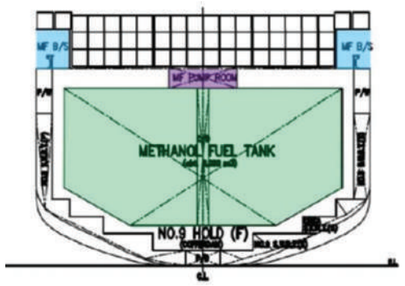
The existing container cargo hold located in front of the engine room's bulkhead has been modified to load methanol fuel, enabling it to operate on the Europe-Asia one-way route. The material for the methanol fuel tank is generally carbon steel applied to the ship's hull, but considering the corrosiveness of methanol, a special zinc silicate coating was applied. The methanol fuel tank was designed as one large block to minimize the conversion time and cost of existing ships and facilitate the conversion work. Additionally, the tank's support structures were placed at key locations to efficiently connect and weld to the existing ship structure.

The fuel tank was designed to be suitable for the harsh environmental loads and internal loads required by KR's rules for the classification of Steel ships. A direct strength assessment was conducted for various fuel oil tank/container loading scenarios to evaluate yield strength, buckling strength, etc. Especially, structural stress concentrations around the main support structures connecting the hull and tank were identified through detailed fine mesh analysis, and appropriately reinforced.

Design for methanol fuel propulsion ship conversion



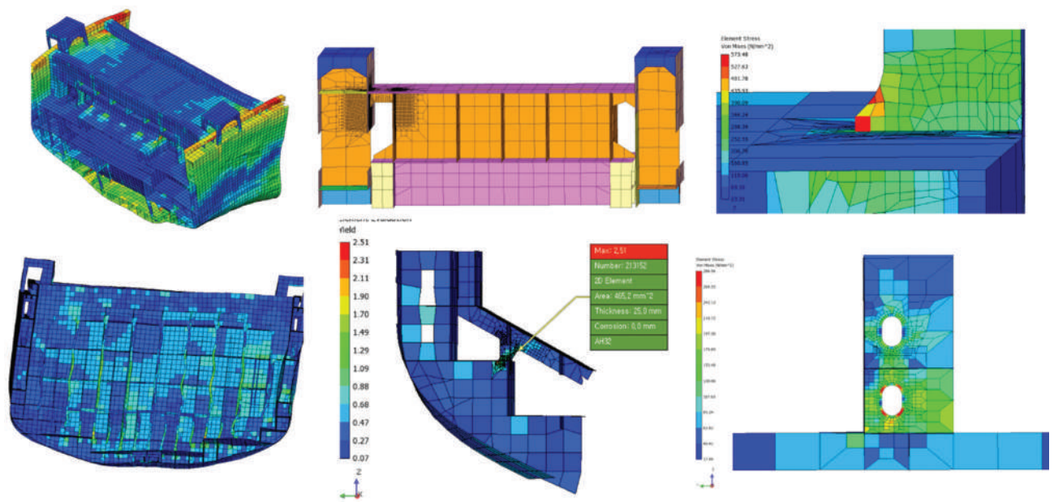
| Elevation View |



| Section View |

M/F Preparation Room (Incl. LFSS, MeOH Serv. Tk)
M/F Storage Tank (abt. 8,000 m³)
M/F Pump Room
M/F Bunkering Station (P&S)

Structural analysis of methanol fuel propulsion ship conversion



KR's roles

KR has actively supported HD Hyundai Marine Solution to secure methanol duel fuel propulsion conversion technology through this joint project, as well as maintaining an active technical support and cooperation relationship with major shipyards, shipping companies, and makers in conducting joint research and new builds of methanol dual-fuel propulsion large container ships, including engine, structure, equipment layout, convention requirements, and risk assessment (HAZID & HAZOP). KR plans to expand its role as a trusted partner to help our customers swiftly respond to the decarbonization era and explore new areas through such close cooperation.