

Hybrid LNG Ship Propulsion

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Sembcorp Marine in Singapore is currently building the world's first hybrid LNG-powered tug fleet, which will replace the existing diesel-powered fleet over the coming years. The Hybrid Control System (HCS) is provided by Invertek Drives Far East. The company relies on M1 system components from Bachmann.

Drive control for tug vessels is highly demanding. Tugs require a highly variable power range, high maneuverability, and immense power: new harbor tugs need 65 tons of bollard pull to manage the enormous ships and tankers in Singapore. With the new ship design, Sembcorp aims to contribute to decarbonization, and, above all, to reduce air pollution. The tugs' two 16-cylinder engines, powered by liquefied natural gas (LNG), are supported by electric motors. "Depending on the desired operating mode and required performance profile, the electric engine can be used for propulsion (Power Take-In, PTI) or as a generator (Power Take-Off, PTO)," says Henry Beh, Managing Director of Invertek Drives Far East Pte Ltd.

The two gas engines deliver an overall output of almost 3,000kW. Sulfur oxide emissions are zero and only very small amounts of nitrogen oxides are produced, removing the need for after-treatment of exhaust gas. In contrast to their diesel-powered counterparts, particle count is negligible.

Efficient Use of Resources

The hybrid system has five drive modes: in 'Harbor' operating mode, propulsion is completely electric and emission-free as the gas engine is switched off. In 'Transit' mode, when not towing vessels, the tug is powered by its gas engine. Any excess power is then stored in the battery. When pulling ships to or from the port, the tug is operated in 'Towing' mode and is powered by the LNG engines only. Then, when high bollard pull is required, 'Boost' mode can be activated, whereby both gas and electric motors are used together to deliver maximum power. Finally, a special feature is available for tug use in firefighting operations: one motor is reserved to operate the firefighting pump, the other is used to maintain the ship's position. "Our controller system ensures that both motor and generator are always operated within the optimal load range, to achieve maximum fuel efficiency and minimum carbon emissions," explains Beh.

Demanding Automation

The combined application in Singapore of a LNG motor with an electric drive is a global first for tug vessels, and control is complex: "Power management of these two motor types, batteries, and converters requires a completely new approach," says Beh. High ship maneuverability must be guaranteed for all performance requirements, and environmental impact must be minimized.

The Hybrid Control System is therefore one of the most critical subsystems of a hybrid vessel. As Beh explains, "It can be

seen as the brain that co-ordinates and controls the various on-board propulsion system components, such as engine, electric motor, battery and thruster. The components must work in perfect harmony to achieve the desired operating efficiency and resource-saving objectives."

Together with Bachmann, Invertek engineers developed an appropriate automation solution. Controller and network redundancy is achieved through a ring topology. The two master CPUs operate in hot standby, with automatic synchronization and bumpless transfer. "Thus, the ship operator gains maximum reliability and operational safety," explains the general manager.

Challenges Mastered

The underlying conditions due to the corona pandemic were anything but straightforward. The entire project – including tender, kick-off meeting, system design, and project co-ordination – had to be executed completely online, without a single face-to-face meeting. Beh praises the cooperation with Bachmann's engineers: "They were available to us at any time and were a great help to our customers." When he opted for Bachmann, he was convinced from the start by the company's extensive experience and impressive references in the maritime industry. "It is important for us that all components are approved for such demanding applications in accordance with stringent marine and offshore standards," adds the Invertek manager. To ensure full compliance in meeting the stringent criteria of marine classification, the design and operating procedure, including FMEA, was reviewed by ABS, who also surveyed the final factory acceptance test. Beh is delighted: "Thanks to Bachmann, we've created an excellent basis for fleet expansion with a total of 12 tugs."

INVERTEK DRIVES FAR EAST PTE LTD

- Founded in 2007 as a subsidiary of British Invertek Drives Ltd.
- Based in Singapore
- The company focuses on the design and construction of energy-efficient and resource-saving electric and hybrid drives

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