

**CMB
.TECH**

 Port of
Antwerp
Bruges

HYDROTUG



POWERED BY HYDROGEN

H₂ DUAL FUEL TECHNOLOGY

CMB.TECH is leading the way in the transition to ships powered by environmentally friendly fuels, and the Hydrotug 1 is a prime example of this. It is the first tugboat in the world to be powered by combustion engines that burn hydrogen in combination with traditional fuel.

With the Hydrotug 1, CMB.TECH confirms its international pioneering role in the transition to ships powered by environmentally friendly fuel. It is the first vessel that uses the BeHydro V12 dual fuel medium speed engines with the latest EU Stage V emissions aftertreatment. By using the dual fuel medium speed engines, the vessel uses clean fuels, resulting in an overall reduction of 65% of traditional fuel consumption and associated emissions in the tugboat's overall cycle. During transits in the port, on which the vessel will operate 90% of her time, the installed hydrogen technology reduces the fuel usage and associated emissions by 75%.

The Hydrotug 1 is part of an integrated greening programme for the Port of Antwerp-Bruges fleet and is being deployed as an important step in the transition to a climate-neutral port by 2050.

VESSEL SPECIFICATION

VESSEL

Length Over All	-	30 m
Beam Over All	-	12,5 m
Depth of propellers	-	5,9 m
Type	-	Tractor tug (<500 GT) with 65 ton bollard pull, double hull
Winch	-	Brusselle electro hydraulic
Class	-	Lloyd's Register ✳ 100A1, Tug, *IWS, ECO ✳ LMC, UMS, LFPF (GF, HY), CAC3

ENGINES

Main engines	-	2x 2 MW dual fuel BeHydro V12 engines with Stage V (SCR and particulate filter)
Auxiliary engines	-	2x 239 kW Volvo Penta EU Stage V

TANK CAPACITY

H ₂ storage	-	54x individual Type III H ₂ storage cylinders of 415 kg of hydrogen at 350bar
MDO(marine diesel oil)	-	61 m ³
Urea (32,5%)	-	7 m ³



H₂ SYSTEM INTEGRATION

- Storage & delivery system developed specifically to promote ventilation.
- CMB.TECH developed H₂ control system utilising advanced leak detection strategies.
- Automated bunker mode.
- Full integration into ships HMI providing key system information.
- Proprietary control software developed and validated for over 15 years.



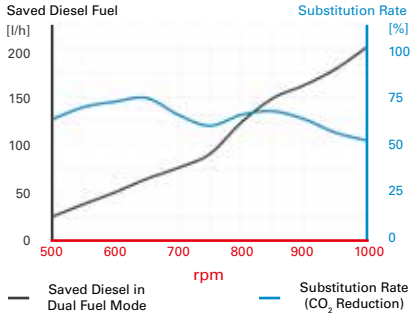
H₂ REFUELLING

- 2x TN25 receptacles (high flow of 240g/s)
- Bunkering manifold with ESD (Emergency Shutdown System)
- 60 mins refuelling time
- No cooling required



EMISSION SAVINGS

CO₂ savings per engine Hydotug1



BEHYDRO H₂ INJECTION SYSTEM

- Proprietary injection system codeveloped with ABC engines.
- Injects H₂ based on engine load.
- Integrated safety features.
- Double-walled H₂ supply with inert Nitrogen gas, used as a safety barrier.

BEHYDRO



SAFETY

Hydrogen as a fuel is inherently safe due to the fact that hydrogen is 14x lighter than air, it diffuses upwards at up to 20 m/s. With a click of a button, the system can be switched to diesel only, instantly shutting down and closing the H₂ system. The technology is based on standards used and proven within the industry for more than 50 years.

- Static and Dynamic Leak Detection strategy
- CMB.TECH's 3 layers of safety
- Classification alongside Lloyd's Register





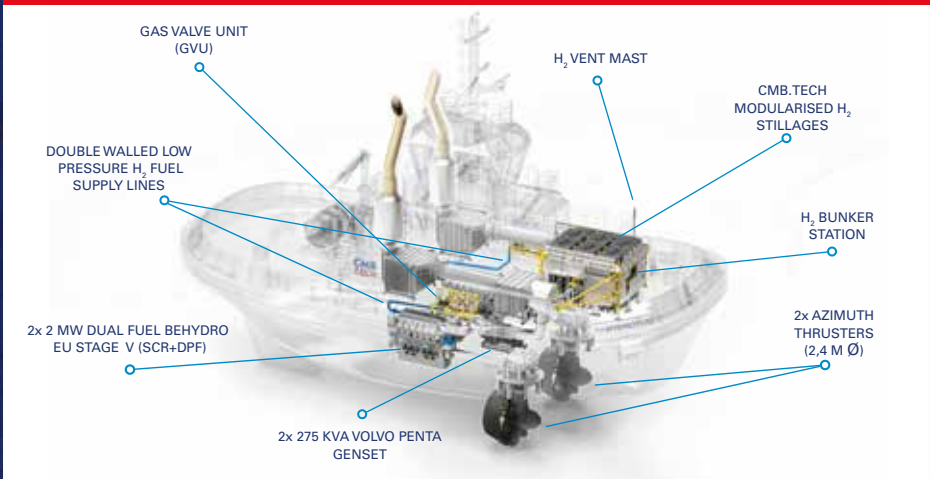


CMB.TECH'S 3 LAYERS OF SAFETY

The hydrogen supply system has three different layers of safety:

1. The first layer is provided by using high integrity components as used on other CMB.TECH projects that exceed normal safety requirements while conforming to all the relevant class and statutory requirements.
2. The second layer is provided by leak detection and system control software that has been developed from the ground up at CMB.TECH. The H₂ control strategy allows for safe and efficient operation of the system and comprises of two parts:
 - **Static Leak Detection** – The integrity of the storage cylinders and gas lines are checked. Any decay in pressure declares a leak, causing the cylinder valves to close, isolating the system and declaring a fault.
 - **Dynamic Leak Detection** – The H₂ control system will regularly perform a dynamic leak test when the engines are running in dual fuel mode. During the test, two stillages at a time are being isolated. Pressures and temperatures are being compared over a calibrated period. If there is any pressure decay, the dual fuel mode is stopped automatically and the engines switch over to diesel only mode seamlessly. The dynamic leak detection process cycles over time for each separate stillage.
3. The third layer of safety is provided by H₂ gas detectors, strategically positioned to monitor any leaking H₂ gas. During the detailed design phase, the optimal positioning was determined within areas like the storage control valve panel, the gas valve units, the vessel's engine room and accommodation spaces. Any detection of H₂ gas will shut the H₂ system down and will report a fault. The gas detectors and alarm panel are kept as a separate system to the existing fire detection system.





STILLAGE SPECIFICATION

Service pressure	-	350 bar
Max. pressure	-	438 bar
Test pressure	-	525 bar
Min. burst pressure	-	788 bar
Working temperature	-	- 40°C to + 82°C
Frame Structure	-	Steel
QTY H ₂ per stillage	-	69 kg
Stillages onboard	-	6 units
Cylinder Life	-	5000 fill cycles
Weight	-	2.5 tons



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