



Sails Return to Shipping  
DEALFENG Build a Green Future With You



# DEALFENG ROTOR SAILS TECHNOLOGY

## Rotor Sail Overview

Dealfeng Rotor Sail takes small deck space with a safe, reliable, fully automatic and long-running system. New-build ship or retrofit ship with the installation of Rotor Sail system can effectively improve the ship's EEDI, EEXI, CII. Compared to other WAPS in the market, Dealfeng Rotor Sails offer a much greater thrust force to the ship forward, occupying small lateral projection area, and the weight is relatively light. Dealfeng Rotor Sail technology is suitable for most vessel types, bulk carriers, general cargo ships, tankers, gas carriers, RoRo/RoPax, cruise vessels and ferries, etc.



## Rotor System

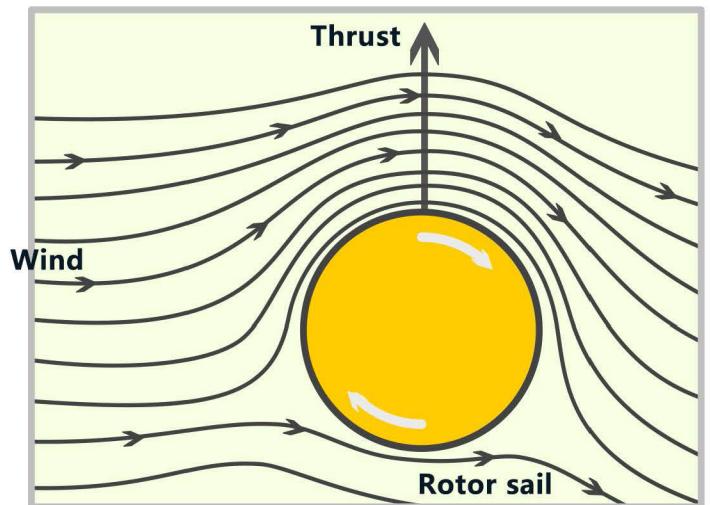
Dealfeng Rotor Sail have five regular sizes to available, such as 15m x 1.8m, 18m x 3m, 24m x 4m, 30m x 5m and 35m x 5m, the height of Rotor Sails also can be customized according to the operation of the ship. The composition of Dealfeng Rotor Sail is divided into five parts below:

- Multifunctional sensor
- Dealfeng control system & mechanic-electrical systems
- foundation (Fixed, Folding and Rail )
- Inner tower
- Composite rotor.

Dealfeng is able to work out a scheme design for the type selection and arrangement of Rotor Sails in accordance with the ship's tonnage, speed and operating characteristics.

## Magnus Effect

Dealfeng Rotor Sail Technology is based on the Magnus effect to generate forward thrust to provide auxiliary propulsion power for the ship. When wind flow meets the spinning Rotor Sail, the air flow increase on one side and decreases on the other side of the Rotor Sail. The change in the air flow speed results in a pressure difference, which creates a lift force that is perpendicular to the wind flow direction. This thrust force can be used to increase the ship speed or reduce the the main engine's fuel consumption. The same principle applies to all rotating spheres or cylinders, which phenomena such as curving ball in flight can be observed in table tennis or football.



## Rotor Installation

Dealfeng Rotor Sails are installed on the customized foundations according to the ship type. The foundations and cables connected to the Rotor Sails are carried out during the construction of new ships or the annual inspection of exiting ships, or with other refitting work of the ships simultaneously. This stage is also called Wind\_Ready. The ships that have completed Wind\_Ready refitting work will lift the Rotor Sails to the ship for installation when they are berthed at the port anytime. Dealfeng can provide customized Wind\_Ready design scheme for the customs with the interesting in WAPS.

## Rotor Operation

Dealfeng Rotor Sails are controlled by Dealfeng System, which can monitor and control the overall operating state through the bridge control panel, and fully runs automatically. In the automatic mode, the corresponding wind speed and direction are recognized by the wind sensor. According to the Magnus principle, Dealfeng Rotor Sails provide the maximum thrust force to the ship by the control system.

# GREEN ENERGY INDEX

## Main Global Shipping Network

To determine a global wind probability chart for the EEDI/EEXI calculation of WAPS, the average of all wind conditions along the main global shipping routes is required. Figure 1 and Figure 2 show global wind probability matrix, which can be visualized in the occurring probability and average of wind energy on the global shipping route. The winds are extremely rich with effective utilization.

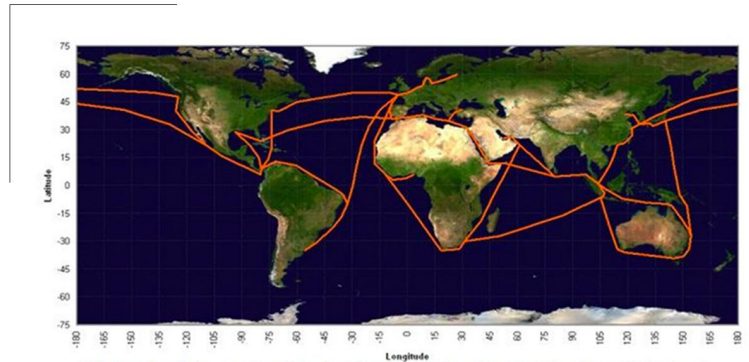


Figure 1 – The main global shipping network used for the wind chart

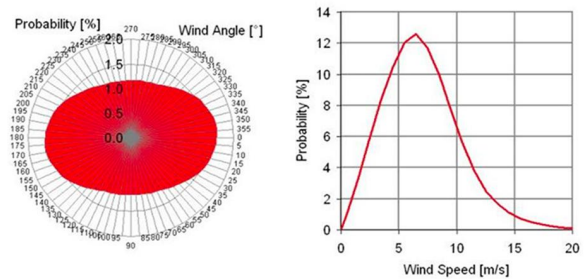


Figure 2 – Resulting wind curves on the main global shipping routes relative to the ship

## EEDI/EEXI Calculation Method

As one of innovative energy-saving technologies, MEPC 77 conference determined the calculation formula of EEDI after the ship installed WAPS, which method also be applicable to the calculation of EEXI.

According to the calculation method, one 82K DWT bulk carrier with 4 sets 24m x 4m Dealfeng Rotor Sails could increase about 10% of EEDI/EEXI.

MEPC 77/WP.8  
Annex 4, page 12

### 2.3 Available effective power of wind assisted propulsion systems (WAPS)

2.3.1 The available effective power of wind assisted propulsion systems as innovative energy efficient technology is calculated by the following formula:

$$(f_{\text{eff}} \cdot P_{\text{eff}}) = \left( \frac{1}{\sum_{k=1}^q W_k} \right) \cdot \left( \left( \frac{0.5144 \cdot V_{\text{ref}}}{\eta_D} \sum_{k=1}^q F(V_{\text{ref}})_k \cdot W_k \right) - \left( \sum_{k=1}^q P(V_{\text{ref}})_k \cdot W_k \right) \right)$$

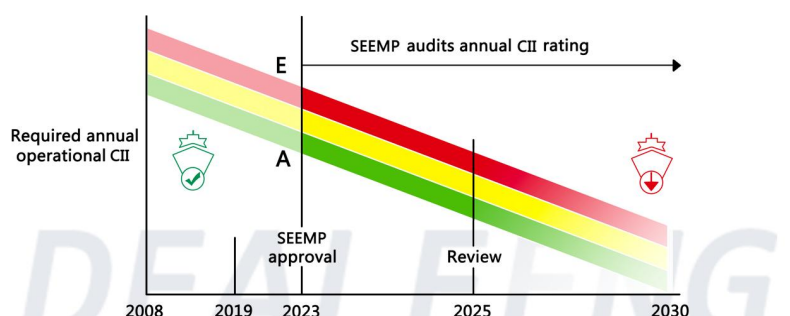
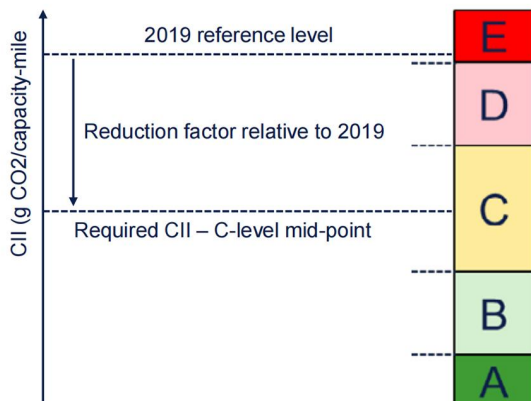
with  $F_1 - F_k \geq 0 \wedge F_{k-1} - F_k \geq 0$

(sorting all force matrix elements in descending order)

and  $\sum_{k=1}^{q-1} W_k < \frac{1}{2} \wedge \sum_{k=1}^q W_k \geq \frac{1}{2}$

(defining q: the number of elements added in the formula)

Since 2019, ships tonnage of 5,000 DWT and above have been reporting their fuel oil consumption data mandated by the IMO DCS. From 2023, cargo, cruise and RoRo/RoPax ships must calculate CII with a required rating of C or better. This means some ships will have to improve their carbon intensity index (CII). The ship with Dealfeng Rotor Sails could effectively enhance the CII.







## Supply Scope

Rotor Sail delivery includes:

- Several Rotor Sails to meet the installation conditions after assembly and commissioning completed
- Suitable foundation for the vessel
- Multifunctional sensor (weather station)
- Dealfeng control system (bridge control panel)
- Supervision and guidance of foundation and mechanical installation

The following foundation types also are available for customers to choose:

- Fixed foundation
- Folding foundation
- Rail foundation

Remarks: The suitable type foundation is offered by Dealfeng. The steel structure of the foundation also can be manufactured by shipyard while the overall design and key parts are provided by Dealfeng.

## On-going projects

At present, Dealfeng has completed the independent design and development on 10m x 2m Rotor Sail for ship of 10k DWT below and 24m x 4m Rotor Sail for ship of 10k DWT above. Both have finished prototype fabrication and land-based test.

In October 2022, Dealfeng has signed a contract with Haiyue company for one new-build 5000 DWT oil tanker (CCS), which will be delivered with Rotor Sail onboard in 2023.

## Advantages of DEALFENG Rotor Sails

### Energy Saving & Emission Reduction

5-20% fuel and harmful emission (such as CO<sub>2</sub>, SO<sub>x</sub>, NO<sub>x</sub>) reduction, which can help shipowner save operating expenses effectively and is good for environment protected.

### Automatic Operation

The control system is easy to operate, can be fully run automatically to minimize the additional workload for the crews.

### High Safety

Dealfeng works closely with LR (Lloyd's Register) to accurately calculate & optimize the system. Structure strength of deck and Rotor Sail also be taken into account on the worst sea conditions to ensure the safety of the ship and the crews.

### Short Installing & Refitting Period

Installing and Retrofitting cycle is about 10 - 20 days.

## Service Assurance





Dealfeng has reached a cooperation agreement with China Ruhai Shipping Engineering Company, which can meet the customer's maintenance and related service guarantee in the global scope.

Due to the continuous improvement of products, the technical parameters in this manual are subject to change without prior notice.




If you have other questions or opinions about this product, but the contents of this product manual are not detailed, please contact us in time, and we will be happy to answer your questions.

Thank you again for your choice and trust!

Main Sizes of DEALFENG Rotor Sails:

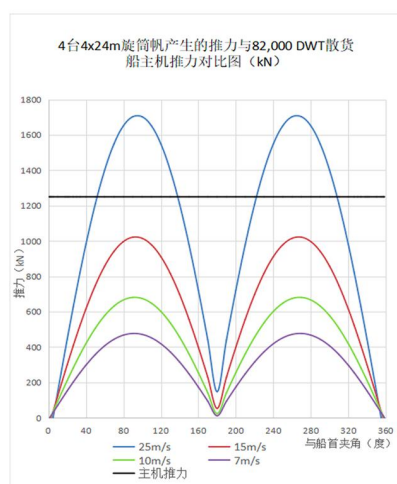
Main Specifications of Rotor Sails			
			
Outer Diameter: 1.8m	Outer Diameter: 3m	Outer Diameter: 4m	Outer Diameter: 5m
Max. Height: 15m	Max. Height: 18m	Max. Height: 24m	Max. Height: 35m
Min. Height: 8m	Min. Height: 10m	Min. Height: 15m	Min. Height: 20m

For cargo operation of the ship, except for customized sizes, the foundation of Rotor Sails can be fixed, folding and rail. The different foundation types can be applicable to the scopes as below.

Foundation Types of Rotor Sails		
		
Fixed	Folded	Rail
Suitable for the vessel without cargo operation and bridge requirement. Fixed Rotor Sail has a wide range of applications with good economic performance, generally installed on oil tanker, chemical tanker, RoRo/RoPax, cruise vessel, passenger ship, ferry.	Suitable for the vessel with complex cargo operations or bridge requirement. Folded Rotor Sail can be lowered from vertical to horizontal, to allow the vessel to pass under low bridge and/or avoid impact to cargo operation. Easy-to-operate and no impact on cargo operation. The folded Rotor Sail is mostly used on bulk carrier or other suitable vessel.	Suitable for the vessel with complex cargo operations. Rail Rotor Sail can be moved along the deck, so cranes can effectively load and unload the cargo without obstruction. Considered to deck arrangement, rail Rotor Sail can be moved along deck longitudinally/transversely. The rail Rotor Sail is mostly used on bulk carrier or other suitable vessel.



<b>Rotor Size</b>	<b>15×1.8</b>	<b>18×3</b>	<b>24×4</b>	<b>30×5</b>	<b>35×5</b>
<b>Foundation Structure</b>					
Material	Steel	Steel	Steel	Steel	Steel
Fixed foundation height (indicative), (m)	2	2	2.5	3	3
Weight of fixed foundation, (tons)	7	9	12	16	19
Folding foundation	Optional	Optional	Optional	Optional	Optional
Rail foundation	Optional	Optional	Optional	Optional	Optional
<b>Inner Support Structure</b>					
Material	Steel	Steel	Steel	Steel	Steel
Weight of support structure (indicative), (Tons)	9	19	31	52	60
<b>Rotor Sail</b>					
Material	Material	Material	Material	Material	Material
Rotor Maximum Speed, (rpm)	300	260	220	180	180
<b>Drive System</b>					
Electric motor nominal power, (kW)	25	35	90	120	132
Motor voltage and input frequency, (V/Hz)	380-690V 50/60Hz	380-690V 50/60Hz	380-690V 50/60Hz	380-690V 50/60Hz	380-690V 50/60Hz
Brake resistor	Standard	Standard	Standard	Standard	Standard
Control system software	Dealfeng System	Dealfeng System	Dealfeng System	Dealfeng System	Dealfeng System
Remote control and monitor system	Standard	Standard	Standard	Standard	Standard
Hydraulic tilting mechanism	Optional	Optional	Optional	Optional	Optional
Rail foundation motor, electronic control system	Optional	Optional	Optional	Optional	Optional
ATEX compliant design	Optional	Optional	Optional	Optional	Optional
Ice class	Optional	Optional	Optional	Optional	Optional
<b>Ambient conditions</b>					
Operational temperature, (°C)	-20-45° C	-20-45° C	-20-45° C	-20-45° C	-20-45° C
Maximum operational wind speed, (m/s)	25	25	25	25	25
Survival wind speed, (m/s)	63m/s	63m/s	63m/s	63m/s	63m/s
Maximum thrust force, (kN)	30	114	219	343	399

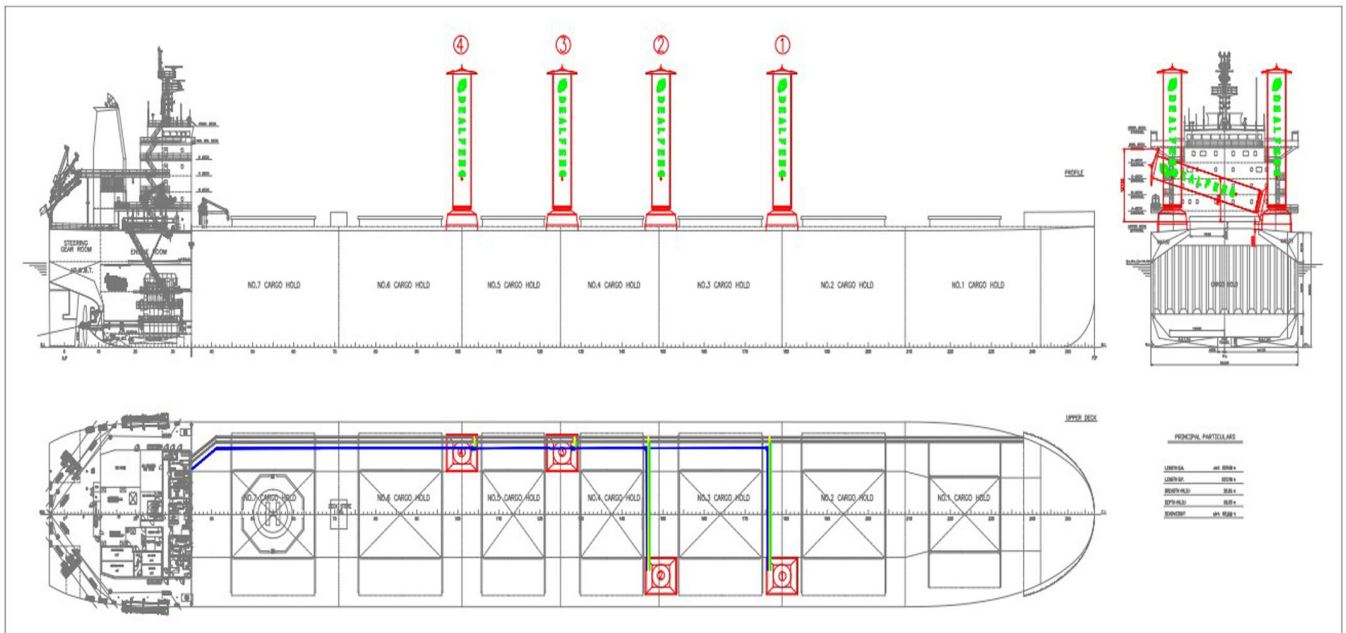


## Fuel Saving Efficiency

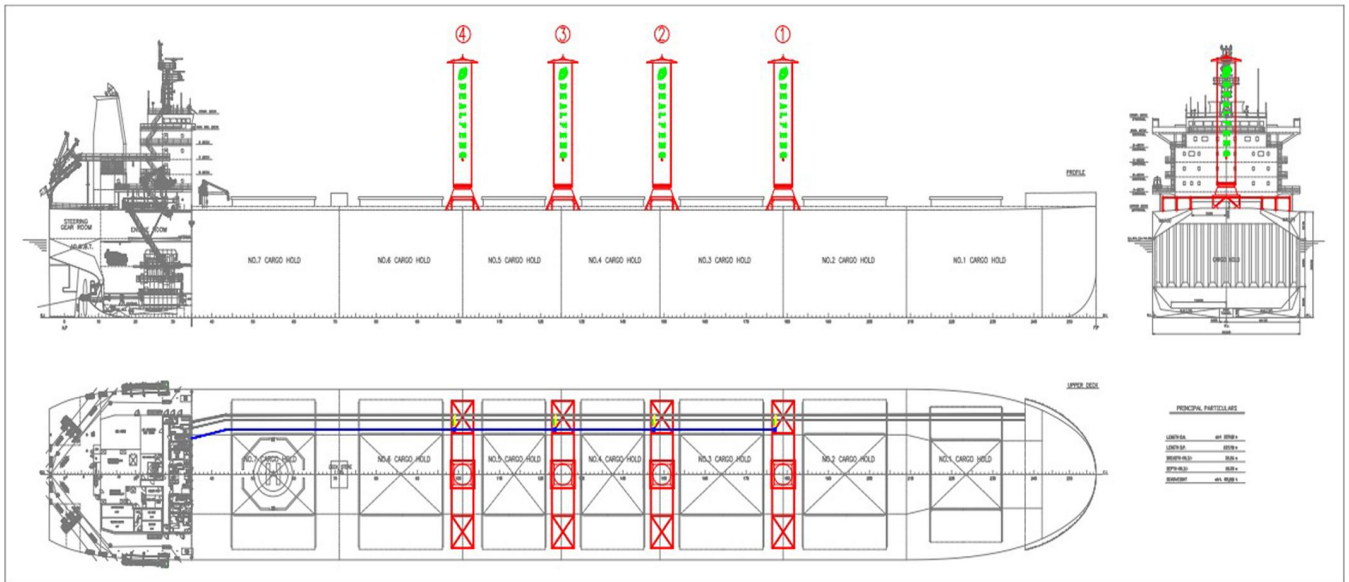
From the calculator of Lloyd's Register (LR), the 82k DWT vessel with 4 (four) 24m x 4m Rotor Sails can realize 9.6% of yearly fuel saving (73.2 tons of monthly fuel saving, total 787.4 tons of annual fuel saving) from Shanghai to Rotterdam.



### GA of 4 (Four) 24m x 4m Folding Rotor Sails on 82,000 DWT Bulk Carrier



### GA of 4 (Four) 24m x 4m Rail Rotor Sails on 82,000 DWT Bulk Carrier



### GA of 4 (Four) 24m x 4m Fixed Rotor Sails on 110,000 DWT Oil Tanker

