



HOW FOULING RELEASE COATINGS CAN SUPPORT YOUR FUEL EFFICIENCY

TECHNICAL PAPER

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1. ECOLOGY

Shipping accounts for at least 90% of the global trade of goods. In terms of distance travelled, shipping is by far the most efficient method of transporting goods¹.

Compared to road and air, transport shipping is most favorable on relative green house gas (GHG) emission measured in CO₂/tonne/mile travelled.

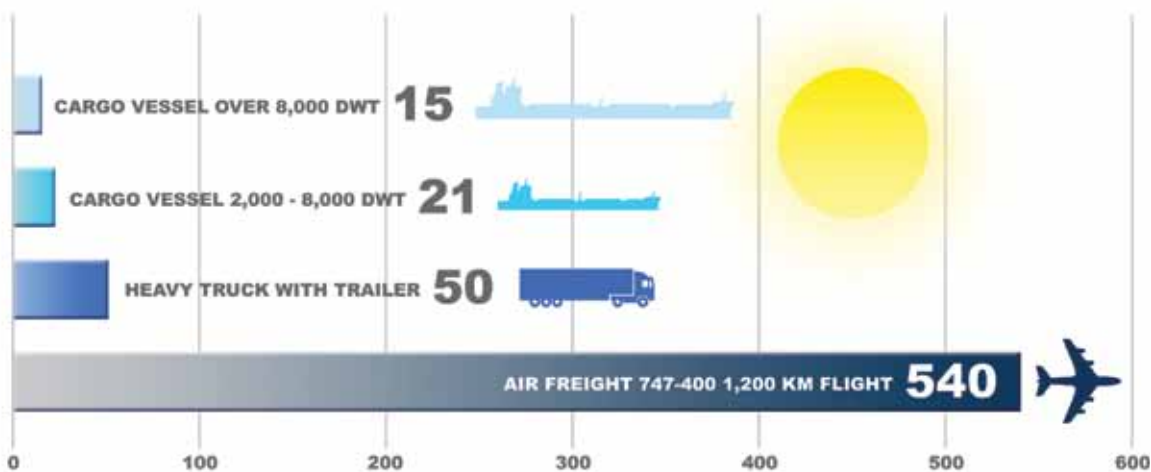


Figure 1. Comparison of CO₂ emission between different modes of transport²

Still, the sheer size of the industry means that shipping accounts for 2-4% of the world's total GHG emission³.

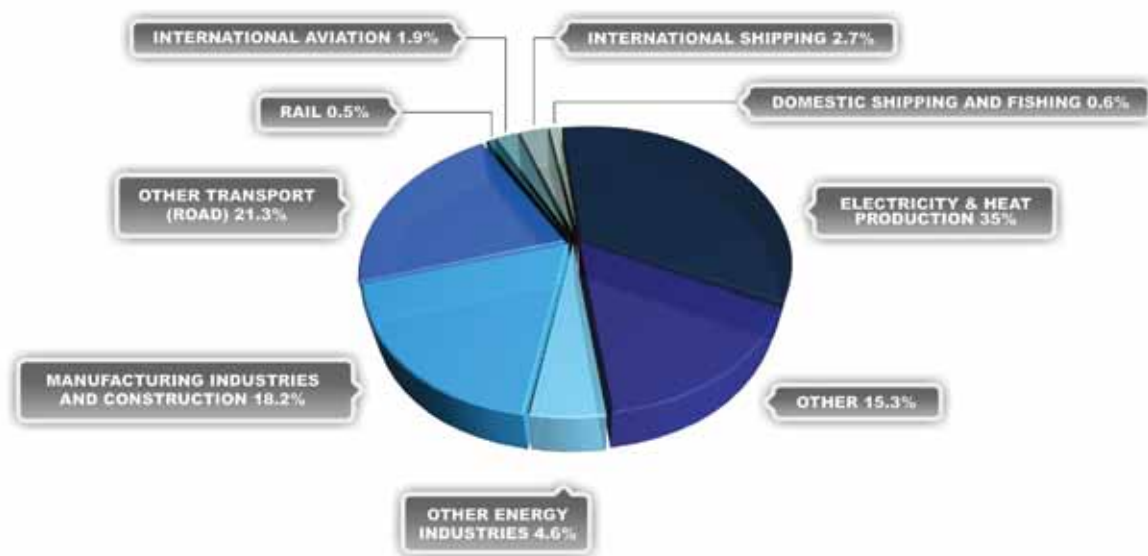


Figure 2. Emission of CO₂ from shipping compared with global total emission⁴

¹IMO MEPC 60/4/21 ²Source: NTM Sweden

³IMO second GHG study 2009 ⁴source: IMO second GHG study 2009

With conditions improving within the global economy, and the prospects of continued growth in global trade, it is foreseen that fuel consumption in the shipping industry will increase in the coming decade. Carbon dioxide emission will also develop at a comparable pace.

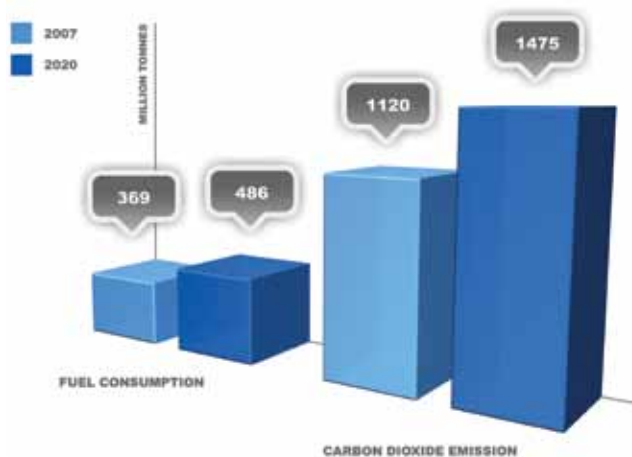


Figure 3. Fuel consumption and carbon emission world's trading ships¹

Longer range emission scenarios show that by 2050, in the absence of policies, carbon dioxide emission from international shipping may grow by a factor of 2 to 3 compared to the emissions in 2007 as a result of the growth in shipping².

2. ECONOMY

The cost of fuel is the largest variable in the operational budget in the Marine industry. With the present bunker fuel rates again exceeding USD 500/tonne this represents in the case of tankers between 67% and 87% of the operating costs³.

The increase in fuel consumption as predicted in the above model amounts 117 million tonnes by 2020. With the current bunker fuel price this means a total cost increase for global shipping of USD 60 billion.

3. LEGISLATION

The IMO Marine Environment Protection Committee (MEPC) has developed a set of measures for reducing shipping's CO₂ emission;

1. Energy Efficiency Design Index (EEDI) for new ships
2. Ship Energy Efficiency Management Plan (SEEMP) for existing ships
3. A market based mechanism; e.g. emission trading

The SEEMP allows companies and ships to monitor and improve performance with regard to various factors that may contribute to CO₂ emission. These include: improved voyage planning; speed management; weather routing; optimizing engine power and use of rudders and propellers; hull maintenance and use of different fuel types.

In **IMO/MEPC 59/24/Add.1/Annex 19** the following considerations are given for hull maintenance;

- Docking intervals should be integrated with ship operator's ongoing assessment of ship performance. Hull resistance can be optimized by new-technology coating systems, possibly in combination with cleaning intervals. Regular in-water inspection of the condition of the hull is recommended.
- Propeller cleaning and polishing or even appropriate coating may significantly increase fuel efficiency. The need for ships to maintain efficiency through in-water hull cleaning should be recognized and facilitated by port States.
- Consideration may be given to the possibility of timely full removal and replacement of underwater paint systems to avoid the increased hull roughness caused by repeated spot blasting and repairs over multiple dockings.
- Generally, the smoother the hull, the better the fuel efficiency.

Conclusion: any measure that saves fuel meets ecological, economic and legislative objectives.

4. A SMOOTHER HULL

The smoothness of the ship hull is determined by a number of factors;

- Mechanical damage from operation
- Condition and total layer build up of the coating system
- Quality of application of the coating system
- Type and technology of the coating system

For providing optimal hull smoothness there are at present two leading coating technologies available:

1. Biocide-free silicone fouling release coatings
2. Hydrolyzing silyl acrylate antifoulings⁴



Silyl acrylate antifouling



Silicone fouling release

A key difference that will be experienced for the ship in service is that silicone fouling release is very smooth right from the outset while the hydrolysis/self-smoothing mechanism of silyl acrylate antifouling requires time to reach optimal smoothness (depending on ship's operational characteristics). The table on the next page summarizes additional key differences.

¹source: IMO MEPC 60/4/21 ²IMO second GHG study 2009 ³MEPC 61/INF.2/13 August 2010
⁴For more details please check technical paper 'the correlation between premium antifouling and fuel consumption'.

Table 1. Key differences between fouling release and silyl acrylate antifouling

	FOULING RELEASE COATING	SILYL ACRYLATE ANTIFOULING
CHEMISTRY	Silicone	Silyl acrylate
MECHANISM	Fouling release	Hydrolysis
ACTION	Physical; low surface energy	Chemical; biocide release
OPTIMAL SMOOTHNESS	Right from the outset	Develops during sailing

5. FOULING RELEASE PERFORMANCE

Performance from the outset

Critical for effective performance and a smooth hull is the quality of surface pre-treatment¹ and application of the fouling release systems. For these reasons coating suppliers provide detailed working procedures and advice on site. With the increasing reference list of fouling release applications, a growing number of ship repair facilities have built experience and good working practice.

PPG's fouling release (SIGMAGLIDE®) applications resulted in excellent hull smoothness profiles, as shown in the graph below.

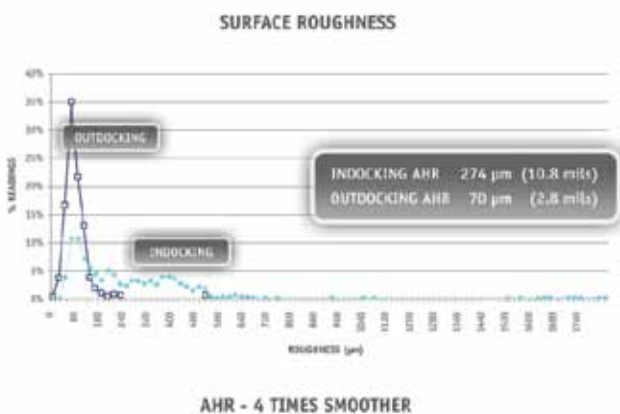


Figure 4. SIGMAGLIDE smoothness of 70 µm (2.8 mils) at outdocking

¹see IMO/MEPC 59/24/Add.1/Annex 19

Independent statistical analysis was performed on two sets of hull roughness data from SIGMAGLIDE dry dockings. Two vessels are considered:

- LNG carrier 283 m (928 ft) length, 16,000 m² (161,458 ft²) UW hull
- Container vessel, 273 m (896 ft) length, 14,300 m² (153,923 ft²) UW hull

The results of the statistical analysis of AHR data from the above two vessels are as follows:

- "The total decrease in power demand due to the dry dock and application of SIGMAGLIDE amounts to 7.5% and 10% respectively"



Prolonged performance

Long-term performance of an undamaged fouling release system during ship service depends on:

1. Quality of application
2. Tolerance of the product towards the application
3. Fouling release performance limiting the settlement of fouling

The first point is addressed by working procedures and advice is delivered on site by trained field technical engineers. The tolerance of the product is highly dependent on properties such as hold-up. Fouling release performance can be defined as the fouling resistance and release properties, i.e., how difficult it is for fouling organisms to settle and how easy they are released once present.

Dry film thickness

For proper low surface energy action the applied dry film thickness of the fouling release system is crucial. However, this is often limited by the hold-up properties of the type of fouling release coating used, especially at the overlapping areas. *SIGMAGLIDE 990* has solved this problem and can therefore be specified at a DFT of 180 µm (7.1 mils).



Fouling Resistance and Release properties

With respect to the intact silicone system, the fouling release properties determine to what extent the initial smoothness benefits are maintained during ship service.

It was studied by Schmidt et al. (Langmuir 2004) that a measure for fouling release properties can be derived from dynamic contact angle measurements. Fouling resistance (how difficult it is for fouling organisms to settle) is expressed in the advancing contact angle (ACA) while the fouling release properties (how easy fouling organisms are released once present) are expressed in the receding contact angle (RCA)

Three fouling release products of different types and origin were compared in this method with these result:

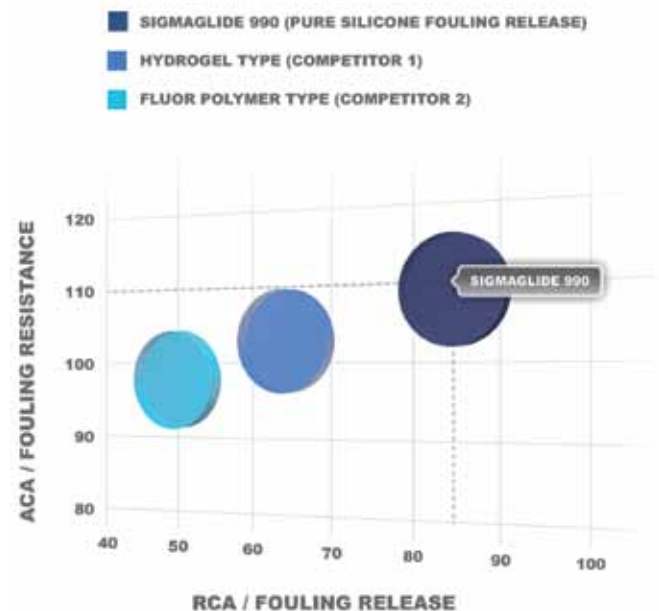


Figure 5. Dynamic contact angle fouling release types

As can be seen in figure 5, *SIGMAGLIDE 990* clearly outperforms other technologies on fouling resistance and release properties.

SUMMARY

SIGMAGLIDE 990 3rd generation pure silicon fouling release coating has superior fouling release performance based on:

- Application tolerance through unmatched hold-up properties; securing minimal required film thickness for optimal fouling release action.
- Superior resistance and release properties; providing prolonged hull smoothness during service

6. TRACK RECORD

SIGMAGLIDE 990 is a third-generation product in the market, building on PPG's extensive track record in commercial fouling release coatings. More than 200 vessels have been applied successfully with *SIGMAGLIDE*.

A cruise vessel is shown in the picture below, which has been applied with *SIGMAGLIDE* and returning from service. The owner has been evaluating the performance of the *SIGMAGLIDE* system and acknowledged fuel savings:

"The silicone paint fuel consumption saving has an average impact of 3-4% in our fleet sailing at average speeds of 15 knots and spending 30% time in port in West Mediterranean and Brazil waters. With a consumption of approximately 13,000 tonnes/year of IFO 380, the saving is around USD 200,000 a year per ship."



References:

1. IMO/MEPC 59/24/Add.1
2. IMO/MEPC 60/4/21
3. IMO/MEPC 61/INF.2
4. IMO second GHG study 2009
5. Schmidt et al., Langmuir 2004, 20, 2830-2836