# The Effect of Biocide Free Foul Release Systems on Vessel Performance

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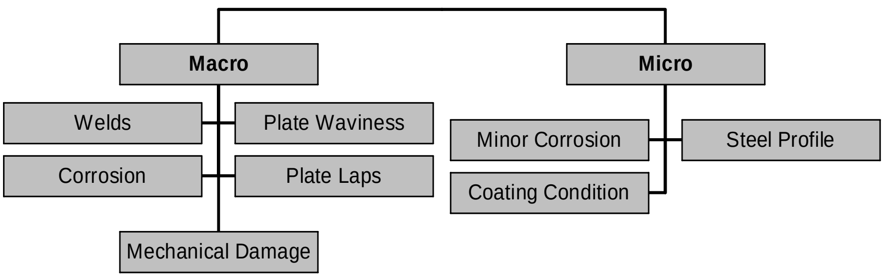
## Introduction

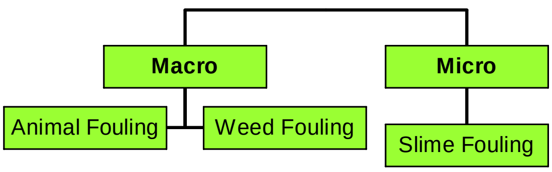
The economic importance of underwater hull condition cannot be understated. Any increase in underwater hull roughness can result in a significant rise in vessel operating costs.
There are two main types of hull roughness : physical and biological (fouling), each with their own macro (large scale) and micro (small scale) characteristics.

- Macro physical roughness can be attributable to plate waviness, plate laps, seams and butts, welds and weld quality, mechanical damage and corrosion
- Macro biological roughness is typically attributable to animal and weed fouling.
- Micro physical roughness can be attributable to steel profile, minor corrosion and coating condition.
- Micro biological roughness is typically attributable to slime fouling

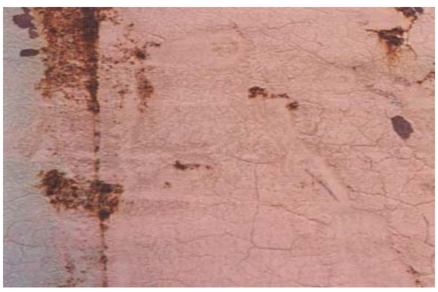
**Physical**




**Biological (Fouling)**




Examples of how coating condition can influence hull roughness:



**Cracking**

**Detachment**

**Touch-up Repairs**

## The Risk and Effect of Fouling on TBT Free Antifoulings and Foul Release Systems

Fouling is a biological phenomenon whose occurrence is difficult to predict and control. The type, severity and extent to which fouling occurs varies greatly depending on the type of antifouling coating plus the vessel's trading pattern and operational profile (i.e. vessel speed and activity). Only by studying a large number of vessels over extended time periods can statistically reliable information be obtained.

**Slime: 1~2% increase in drag**

**Weed: up to 10% increase in drag**

**Shell up to 40% increase in drag**

Any increase in underwater hull roughness will increase hull frictional resistance or vessel drag, resulting in an additional power requirement with increased fuel consumption and cost to maintain vessel speed. Conversely, maintaining constant power will result in decreased vessel speed and longer voyage times. Whilst this may appear obvious, my experience has shown that the principles, performance effects and costs of increased hull roughness on vessel operating efficiency may not be widely understood.

# The Effect of Coating Roughness on Ship Performance

The effect of coating roughness on ship performance can be calculated using the Townsin formulae shown below[1]:

**Fractional Added Resistance ($\Delta R/R$) for going from a smooth (AHR = $k_1$) to a rough (AHR = $k_2$) surface:**

$$\Delta R/R = \Delta C_F/C_T = 0.044[(k_2/L)^{1/3} - (k_1/L)^{1/3}]/C_T$$

**Where:**

Δ = Change in resistance, power, speed or propeller efficiency due to increased roughness

Δ

$C_F$ = Frictional Resistance coefficient increase

$C_T$ = Total Resistance coefficient = ([Total Resistance]/0.5 $\rho$ S $V^2$)

or very approx. = 0.018 $L^{-1/3}$ (if $C_T$ value cannot be found otherwise, and where L is in metres)

$\rho$ = Sea water density

S = Surface wetted area of vessel

V = Speed of vessel

L = Length between perpendiculars of vessel

**Fractional Power increase ($\Delta P/P$) at constant speed for going from a smooth (AHR = $k_1$) to rough (AHR = $k_2$) surface:**

$$1+ \Delta P/P = (1 + \Delta R/R)\,(1+\Delta\eta/\eta)^{-1}$$

**Where:**

P = Shaft Power

$\eta$ = Open water propeller efficiency

As a handy guide, the following approximate relationships hold for a Ro-Ro and a Tanker, which typify Liner and Bulk Cargo ships:

For Ro-Ro ships: $(1+\Delta\eta/\eta)^{-1} = 0.17\,(1 + \Delta R/R) + 0.83$

For Tankers: $(1+\Delta\eta/\eta)^{-1} = 0.30\,(1 + \Delta R/R) + 0.70$

Figure 1 below shows the increase in power required and hence the typical increase in fuel consumption necessary to maintain vessel speed of a fast fine ship (e.g. Ro-Ro) versus increasing physical hull roughness.

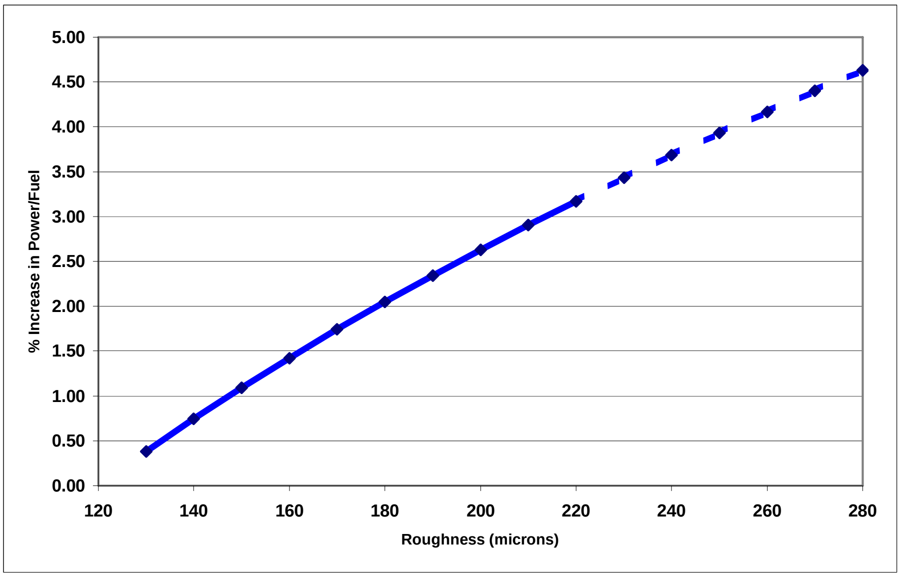
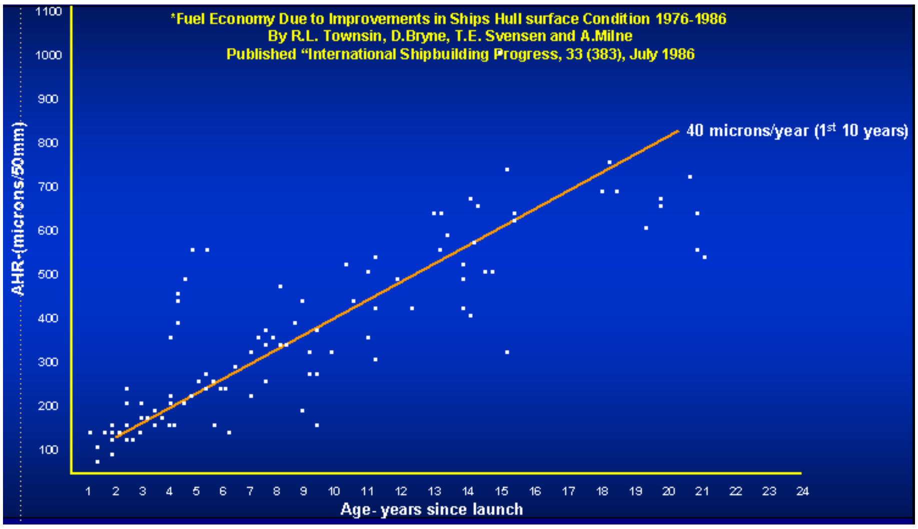



**Figure 1.** Typical Increase in power/fuel required to maintain vessel speed of a fast fine ship vs increasing hull roughness

**Hull roughness**

Note: Above 225 microns (which is undesirably rough) calculations are less precise, hence the dotted line.




## How Roughness is Affected by Antifouling Type

During the period 1976 – 1986, two substantial hull roughness studies were carried out [2]. These studies showed that over time, ships generally get rougher due to mechanical damage from anchor chains, grounding, etc. and from mechanical damage, cracking, detachment, corrosion etc. of applied surface coatings. The increase in roughness was found to differ markedly depending on which antifouling type was used. With traditional antifoulings the increase in Average Hull Roughness (AHR) was found to be 40 microns per year. Foul release systems have low initial roughness (75-100 microns) and good mechanical properties. As a result foul release systems are expected to increase in roughness by only approx. 5 microns per year.
There are two main types of fouling control technology :

- <u>Silicone Foul Release technology</u> These products do not use biocides to control fouling but rely on a slippery "non-stick" surface to make it difficult for fouling to adhere. Foul release systems provide a smooth surface (typically100 microns).
- <u>Fluoropolymer Foul Release technology</u> These products do not use biocides to control fouling but rely on fluoropolymer technology to provide an ampiphilic "non-stick" surface to make it difficult for fouling species to adhere. Fluoropolymer Foul release systems provide a smoother surface (typically 75 microns) and better resistance to slime than silicone systems.

## Advantages of Foul Release Systems

No release of biocide in to the environment

- Unlikely to be affected by future environmental legislation
- Reduced paint volume (and solvent emitted) on first application (see table below)
- Good antifouling performance on a range of vessel types
- Good resistance to mechanical damage
- Reduced hull roughness giving improvements in vessel performance and reducing emissions
- Less time in dock, paint required and application costs at future dockings

**<u>*Re-coat volumes on Gas Carriers with foul release coating:</u>**

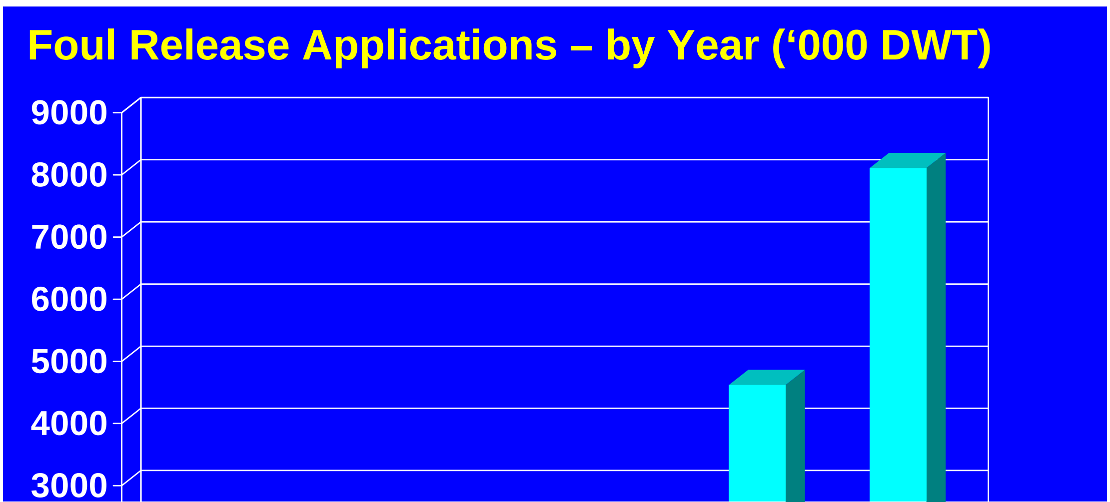
| Vessel | Application Date, Volume | Next DD Date, Volume ,% | | Time in Dock |
|---|---|---|---|---|
| **“Al Khor”** | **11/01, 8470 l** | **05/04, 620 l** | **7.3%** | **(7 days in dock)** |
| **“Broog”** | **5/03, 7750 l** | **10/05, zero** | | **(4 days in dock)** |
| **“Al Wakrah”** | **10/03, 8510 l** | **5/06, zero** | | **(4 days in dock)** |
| **“Al Wajba”** | **05/05, 8480 l** | **6/07, zero** | | **(4 days in dock)** |
| **“Doha”** | **04/04, 8490 l** | **5/07, zero** | | **(3 days in dock)** |

*Source: International Dataplan

## Disadvantages of Foul Release Coatings

- Higher initial cost of paint and application
- Quality of application is very important
- Masking and dedicated equipment required
- As product is biocide-free, resistance to slime for silicone foul release systems are lower than some biocidal anti-foulings

**Results From the Fleet in-service**

## Summary

- Foul Release Products give lower hull roughness than biocidal AF
- Main advantages are improved vessel efficiency, reduced environmental impact and reduced future drydock time and costs
- Main disadvantages are higher initial costs and more difficult application process
- A wide range of vessels have achieved efficiency improvements by using foul release products
- The number of foul release applications is increasing rapidly

**References**

1 Townsin, Dr. R.L.: "Workshop – Calculating the Cost of Marine Surface Roughness on Ship Performance" WEGEMT School on Marine Coatings at the University of Plymouth, UK, 10-14 July, 2000.
2 Townsin, R.L., Byrne, D., Svensen, T.E. and Milne, A.: "Fuel Economy due to Improvements in Ships Hull Surface Condition 1976-1986", International Shipbuilding Progress", 33, (383), July 1986

*John Willsher graduated from Salford University in 1986 with a degree in Chemistry. He then joined International Paint and worked as a Paint Chemist in the development laboratories, before spending five years working in the Marine Marketing Department. Between 1995 and 2006 he worked for various companies in the UHP hydroblasting and surface protection contracting industries. His role within these companies covered General Management and ultimately Managing Director positions. In 2006, he re-joined International Paint as Market Manager for Foul Release (Intersleek) products for EMEA (Europe, Middle East and Africa).*