The Smoothing Effect of TBT-free Antifoulings

Background

Back in 1972 Jotun Marine Coatings through it's partnership with NOF, Nippon Oil and Fats Co. Ltd (now NKM) launched the first "Self-Polishing TBT-copolymer A/F" Takata LLL. All the major paint manufactures were quickly on the market with similar technologies. The major benefit of these new products was the antifouling predictability and the possibility to prolong the dry-docking intervals from 12-18 months that was the standard at that time, to periods up to 60 months. The market responded and within a short period of time 80% of the world's merchant fleet had converted to the new TBT-copolymer products. The additional benefit of smoothing or hull roughness reduction was also investigated and the findings supported the results reported by H. Lackenby 10 years earlier. These results showed the correlation between the roughness of the underwater hull and the effect on the vessel's fuel consumption and was quickly used as a "rule of thumb":

> *1% change in power (fuel consumption) for a 10 μm increase in roughness from the newbuliding value and up to a value of approx. 230 μm.*
>
> *From 230 μm and above 0,5% change in power (fuel consumption) for a 10 μm increase in roughness*

As the cost of fuel oil is the largest operating cost of a traditional vessel, the benefit of smoothing and thereby reduction in fuel consumption, offered by the hydrolysing (chemical reaction) Self-Polishing TBT-copolymer A/F's, was a huge product benefit. As an example, a Panamax tanker will consume approx. 40 tonnes/day of fuel oil while a VLCC will consume approx. 80-95 tonnes/day.

We all know the negative environmental focus given to the TBT-containing antifoulings that started in the late 80's and lead to the ban of application of TBT-containing antifoulings by January 1st 2003.

Present situation

Following the ban of TBT-containing antifouling by IMO, all paint suppliers to the marine market are now offering TBT-free products that are claimed to be equal to the TBT-containing products with regards to antifouling performance, self polishing effect and also offering the benefit of reduced fuel consumption by hull roughness reduction. The main difference today compared to the situation in the mid 70's, when as all suppliers had the TBT-copolymer technology, is that all the suppliers offer different and more expensive technologies. The performance of the latest TBT-free technologies is, in general, far from equivalents to the best TBT-antifoulings and many of the products does not perform (foul free) for as much as 36 months on a consistent basis. The main difference as the market is changing to the "new" TBT-free products will be an increase in fuel consumption due to:

- lack of reduction in hull roughness (rather the opposite)
- fouling on hull due to thick leached layers preventing proper release of actives/biocides

The main challenge, as we see it, for the ship owners and Management companies is that they have limited practical experience with the last generation of TBT-free products and will therefore, in many cases, have to base their selection of AF on claimed features from the paint suppliers and/or price/litre.

Practical self-smoothing experience with the SeaQuantum range

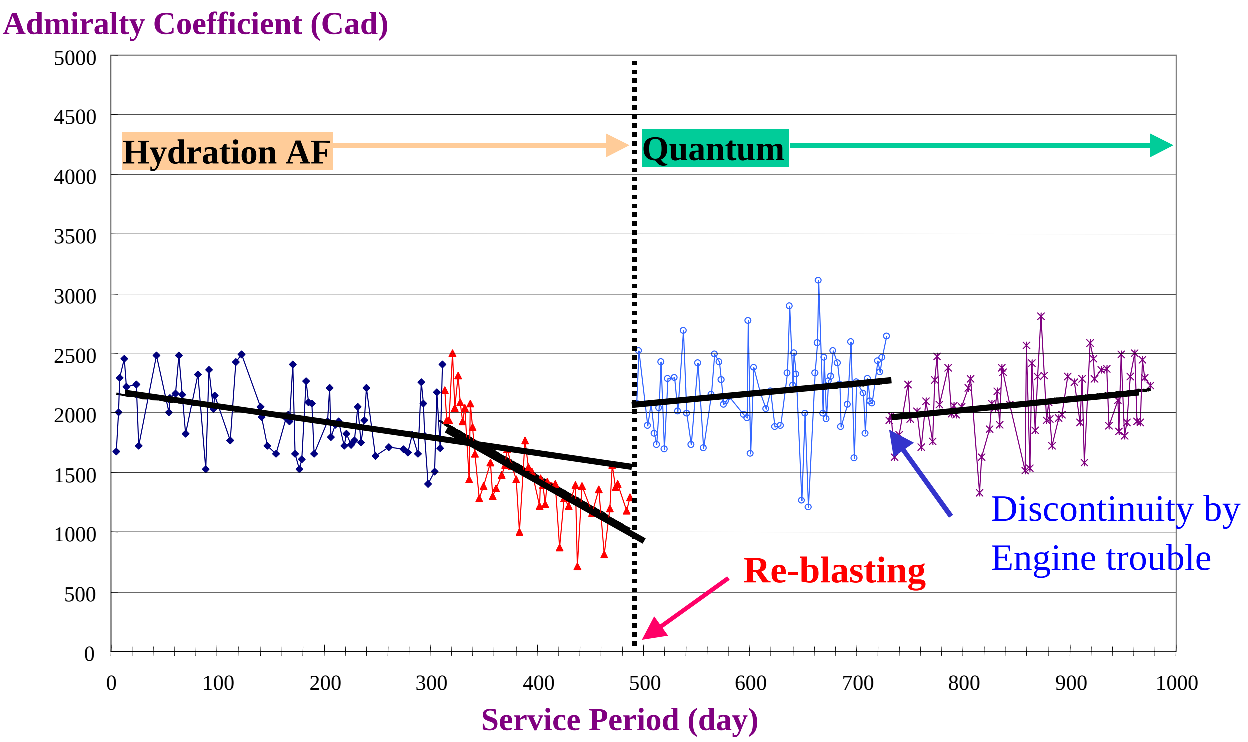
The Quantum product was initially launched by our partner in Japan NKM back in 1993 as a result of the Japanese ban of TBT-antifoulings in 1990. Jotun launched the Quantum range as SeaQuantum in year 2000. A number of trials have been carried out since 1993 to investigate the smoothing/hull roughness reduction effect of the Quantum product range.

Example 1

By analysis of the fuel consumption with two different technologies before and after dry-docking the below findings were made using the Admiralty coefficient (Cad)

$$Cad = Dv^{2/3} \times Vs^{3}/FOC$$

Cad = Admiralty coefficient
Dv = Displacement volume
Vs = Sailing speed
FOC = Fuel oil consumption



The figure clearly shows that while the admiralty factor is gradually reduced (Fuel oil consumption is increasing) with the hydrating antifouling (left part of graph) it is increasing with SeaQuantum (right part of graph). Concluding that SeaQuantum reduces the fuel oil consumption while the hydrating product increases the consumption.

Example 2

The total resistance to movement which must be overcome by the engine power of a ship is made up of frictional resistance, wavemaking resistance and wind resistance. For a merchant vessel the frictional resistance contributes to approx. 80% of this total.

The M/T Olympic Legazy (VLCC) was coated with SeaQuantum Classic and delivered from new-build in 1996. Following the delivery the fuel consumption was closely monitored. By using the "Engineers abstract of log" each voyage was analysed (adjusted for bad weather and variation in vessel speed) and the result is given in the graph below.

Voyage Period		Average Consumption	Calibrated	Fuel Comsumption	Commencement of Voyage	Days	Months
Year	Date	(ton/hrs.)	(ton/hrs.)	Ratio(%)			
1996	02/Mar - 28/Apl	3.4488	3.4488	100.0	02/Mar/1996	0	0.00
	10/May - 19/Jun	3.3693	3.3693	97.7	10/May/1996	69	2.30
	27/Jun - 28/Jly	3.3405	3.3405	96.9	27/Jun/1996	117	3.90
	31/July - 02/Oct	3.4484	3.4484	100.0	31/Jly/1996	151	5.03
	13/Oct - 05/Dec	3.1063	3.1063	90.1	13/Oct/1996	225	7.50
	07/Dec - 16/Jan	2.9881	2.9881	86.9	07/Dec/1996	280	9.33
1997	20/Jan - 15/Mar	3.1849	3.1849	92.3	20/Jan/1997	324	10.80
	21/Mar - 30/Apl	3.1045	3.1045	90.0	21/Mar/1997	384	12.80
	02/May - 02/Jun	3.5338	3.099	89.9	02/May/1997	426	14.20
	05/Jun - 11/Jly	3.4213	2.9865	86.6	05/Jun/1997	460	15.33
1998	28/Apl - 03/Jly	3.6804	3.2456	94.1	28/Apl/1998	787	26.33
	08/Jly - 29/Jly	3.5835	3.1487	91.3	08/Jly/1998	858	28.60
	01/Aug - 25/Aug	3.5892	3.1544	91.5	01/Aug/1998	882	29.40
	30/Aug - 16/Oct	3.3763	2.9415	85.3	20/Aug/1998	911	30.37

In the course on the first 24 months the fuel consumption was reduced by 10-15%. This is not all due to the antifouling system but a share of it certainly is. The vessel dry-docked in Dubai after 31 months free from fouling and with a measured reduction in roughness of 20 µm.

Example 3

Two test patches was applied on a VLCC in 2001, one with SeaQuantum Classic and one (top of the range) from one of our main competitors. The main antifouling system was a TBT-antifouling. Pictures of the test patches following 24 months in service is shown below.

SeaQuantum Classic

Top of the range competitor AF

Roughness measurements (BSRA hull roughness gage) made showed the following results:

Antifouling	Average hull roughness (µm)	Range
TBT-system	130	86-234
SeaQuantum	134	63-235
Competitor	184	79-286

SeaQuantum antifouling performance was excellent and gave a soothing effect comparable with the TBT-system while the competitor system, although free from fouling, had a much higher roughness.

Example 4

The crude oil tanker (96000 dwt) below shown docking in (Singapore) had at that point been trading (Asian waters) for 30 months with a SeaQuantum Classic system. As the picture show, the antifouling performance is very good.

During this dry-docking two hull roughness measurements were carried out, one just after entering the dock and the second after having completed the application of SeaQuantum Classic. The results are given in the table below.

	AFTER WASH DOWN			AFTER PAINTING		
	AVERAGE (µ)	MAX (µ)	MIN (µ)	AVERAGE (µ)	MAX (µ)	MIN (µ)
FLAT BOTTOM (P) SIDE	75	120	37	94	186	39
FLAT BOTTOM (S) SIDE	77	130	33	102	167	49
SIDE BOTTOM (P) SIDE	87	185	36	115	210	48
SIDE BOTTOM (S) SIDE	91	178	30	121	264	62

As expected the dry-docking procedure resulted in an increase in the hull roughness, from 89 to 118 µm (side bottom). However this must also have been the case at the previous dry-docking, ie this indicates that the SeaQuantum Classic system has given a hull smoothing effect of almost 30 µm in 30 months of trading. Given the "rule of thumb" (Lackenby) this would have given an average fuel saving of 2% or 1 tone of fuel/day.

Conclusion

The TBT-copolymer antifoulings served the market for 30 years with excellent predictability and antifouling protection. The in-built hull smoothing of these banned products also gave (is still giving) contribution to the overall fuel oil cost. However, the change in technology to TBT-free antifoulings will, in general, increase the fuel oil consumption as many of the current top of the range products does not offer this reduction in hull roughness. SeaQuantum Classic and Plus have shown to offer hull roughness reduction similar to the TBT-copolymer antifoulings and will contribute to maintain a vessels operation, both with regards to speed and fuel consumption. As a result of the huge variation in product performance the selection of antifouling has become more difficult.

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