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Project Green Efforts for Existing Ships

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SYNOPSIS

The use of homogenisers in pre-treatment of heavy fuels is controversial, the major manufacturers of fuel separators advocate against installation of homogenisers upstream separators, arguing that it will strongly reduce separation efficiency of contaminants and water. On the other hand, suppliers of homogenisers claim 80 % reduction in sludge volumes, improvement in combustion, exhaust gas emissions and machinery maintenance by the use their equipment. A large number of ships are equipped with fuel homogenisers, however, the environmental and fuel consumption improvements and operational aspects have not been adequately documented so far.

The harmful environmental effects of organotin compounds were recognized by IMO in 1990. On 5 October 2001, a diplomatic conference adopted the IMO convention on the control of harmful anti-fouling systems on ships by consensus. This convention states a global prohibition on the application of organotin compounds which act as biocides in anti-fouling systems on ships by 1 January 2003, and a complete prohibition on the presence of organotin compounds which act as biocides in antifouling systems on ships by 1 January 2008.

Many ship owners have for several years tested tin-free antifouling paint systems, both in form of test patches and for full hull bottoms, with varying success. Some ships have experienced severe fouling and speed loss. Thus, there is a need for further testing and documentation on performance of TBT-free antifouling paint systems.

INTRODUCTION

The project “Green Efforts for Existing Ships” is part of a Norwegian national R&D program “MARMIL”, initiated by the Norwegian Shipowners' Association and the Research Council of Norway, and with funding also from the thirty participating industry partners. The objective of the project is to establish and document operational experience from environmental efforts applicable for existing ships. Such experience and documentation is gained through implementation onboard sailing ships in normal operation. The project were started in 1998, and have pr today covered six different aspects:

- NOx emission rating of the main engine onboard a 6000 tdw paper carrier
- Exhaust gas emission measurements onboard Viking Lines' "Mariella", for evaluation of installed "Humid Air Motor", HAM technology
- Low sulphur marine fuels, effects on emission improvements and operational aspects
- Documentation of emissions from ship operation
- Fuel pre-treatment, fuel homogenisation and fuel/water emulsion
- TBT-free anti-fouling paint test programme

This paper will concentrate on the presentation of the two last part projects, test activities performed to identify possible effects from fuel homogenization and water emulsified fuel, and a test programme for documentation of performance of TBT-free anti-fouling paints.

EFFECT OF FUEL HOMOGENISATION

The effect of using homogenisers in pre-treatment of heavy fuels is controversial, and the experiences are differing. There are reports claiming reduction in fuel consumption and exhaust gas emissions, and reduction of deposit formation in the

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engine and exhaust boiler heat surfaces. The manufacturers are also claiming reduced sludge production and less filter clogging. Reduced sludge production means fuel savings and reduced incineration. In combination with water injection, a reduction in NOx-emissions is obtainable.

As important as to document the possible benefits of homogenisers is to investigate to which extent the homogeniser affects the separators ability to clean the fuel, and how it will effect the performance of the machinery through abrasive wear or other secondary effects. Leading manufacturers of fuel separators argue that use of homogenisers upstream the fuel separator will strongly reduce the separation efficiency of both water and other contaminants.

A considerable number of ships are to day equipped with homogenisers, and further more to be delivered. However, the environmental and fuel consumption improvements and operational aspects have not been adequately documented so far. This is the background why the project in 1999, in collaboration with two ship owners, established this test programme to investigate the possible effects of fuel homogenisation. In spring 2000 this group was extended to a total of twelve ship owners, with that in common of either operating ships with homogenisers or they will be in near future. The group also include the two major manufacturers of fuel separators, Alfa Laval and Westfalia, and the homogeniser manufacturer Ashland/Drew Marine Division. The group meets half-yearly for presentation of results and detailing further activities.

Several ship owners has offered test ships for the investigation. The onboard tests cover both fuel homogenisation and use of water-emulsified fuel. Measurements and recordings cover machinery performance parameters, fuel consumption, dynamic cylinder pressures, exhaust gas measurements and numerous visual inspections in addition to a comprehensive number of fuel and sludge samples and analysis. All visits onboard also comprise interview and discussions with the engine staff, who has also been involved in performed measurements and fuel sampling

The objective of the test activity has been to answer and document following questions?

- Do fuel homogenisation reduce sludge production ?
- Will fuel homogeniser situated upstream separators hamper the separator efficiency?
- Will fuel homogenisation improve the engine combustion quality?
    - reduction in fuel consumption?
    - less harmful exhaust gas emissions?

Reduction in sludge production

To be able to investigate possible sludge reduction potential, one has to clarify what exactly is meant by the term "sludge". Is it the total amount of material discharged from the fuel separator, or is it the part of the discharge with density higher than water?

The volume discharged from the fuel separator normally consists of three separate constituents or parts, the part with density higher than water, the water part, and the fuel part. The relative amount between them depends on fuel quality and on the type and adjustments of the fuel separator. All tests performed onboard the test ships verified that for to days normal ISO classified fuels the levels of contaminants, and hence the "Real Sludge" part with density higher than water, is fairly small. Tests performed onboard MT “Berge Stavanger”, equipped with Alfa Laval Alcap separators, evidenced just a spoonful of heavy sludge, the remainder being water. The tests were done with the sludge discharge line disconnected and the sludge collected in a bucket. Tests performed with and without SR homogeniser in operation gave identical results. This is confirmed by similar tests on other test ships. Consequently, for most ISO certified fuels the “real sludge” part represents a very small quantity, and loss of energy.

The major part of the energy lost through the separator discharge volume is therefore connected to the fuel part. Experience from several of the project test ships indicated fuel parts up to 50% of the total sludge volume. However, dependent on type of separator, if the separators are adjusted for a minimum of fuel discharge, the energy lost might be fairly small. This emphasises the importance of properly adjusted separators. On the other hand, if the sludge is incinerated containing large amounts of water, the fuel consumption for incineration will be high. Proper separation/drainage of the water from the remaining sludge is therefore of importance for the incinerator fuel consumption. Possible recovery/utilisation of all/parts of the sludge phase will be topic of further project investigation.

The main purpose of this part of the investigation has been to document whether the use of fuel homogenisation will reduce the amount of "real sludge", and maybe also if fuel homogenisation allows for prolonged discharge intervals. All the results from the onboard tests have been on ISO certified fuels with low content of contaminants, and have revealed no effect from fuel homogenisation. Still remains to establish if the effect is more marked on more contaminated fuels and for fuels with low stability margin. A project plenary meeting in June 2002 decided that a continuation covering such fuel qualities should be done more conveniently under controlled laboratory conditions. Such tests are planned this autumn.

Influence on separator efficiency

Separator manufacturers as well as several engine manufacturers are critical to homogenisers upstream the fuel separators, and strongly argument that it fosters low separation efficiency of both water and particles. A vital part of the project work has therefore been to document possible changes in separator efficiency when operating on homogenised fuel.

Influence on separation efficiency has been investigated by taking fuel samples from the fuel system with and without the homogeniser in the pre-treatment system in operation. All fuel samples were analysed by DNV Petroleum Services according to the standard “Veritas Fuel Quality Test Programme” parameters, with total sediment existent, total sediment accelerated and asphaltenes in addition. However, the major problem has been that the fuels content of contaminants has generally been very low, making exact establishment of separation efficiency hard to obtain.

Of special interest has been the separator’s ability to remove particles like aluminium and silicon, so-called catalytic-fines. These small particles of powdered aluminium-silica based material, which are remainders from the refinery cracking process, can cause wear of fuel pumps, piston rings and cylinder liners. The combined amount of aluminium and silicon is limited to 80 mg/kg for all residual fuel grades by the ISO standard.
In addition, the separator efficiency regarding water removal has also been investigated.

Table I shows the results from analysis of fuel and sludge samples collected during a visit onboard MV “Probo Gull” during a journey between Taiwan and Japan. The samples were taken before and after the fuel separator on untreated reference fuel, R, and with homogenisers in operation, H1 + H2.

As comes forth from the results the level of sediments was reduced from 0.02 % m/m to 0.01 % when passing the separator, independent of homogenised fuel or not. The combined content of aluminium and silicon from the fuel samples was higher than from the other test vessels, but well below the 80 mg/kg limit (~40 mg/kg). A reduction in aluminium and silicon content was registered when comparing samples before and after the separator, both with untreated and homogenised fuel. The separation efficiency was in the range 50-70 %, and no significant changes in separator efficiency between untreated and homogenised fuel is evidenced.
The water content in the fuel samples was reduced from 0.5 % to 0.2 % for the reference case and from 0.4 to 0.3 for the case of homogenised fuel, indicating a lower ability to separate water from homogenised fuel.

A special test was performed onboard MT “Berge Stavanger” to further investigate the separator ability to separate water from homogenised/emulsified fuel. Onboard MT Berge Stavanger, the H1 homogeniser is arranged in an own circulation circuit connected to the settling tank. Just upstream the homogeniser a water injection unit was installed, and water injected and emulsified through the homogeniser until a water content in the settling tank of near 1 % was achieved. In this mode, fuel samples were collected before and after the fuel separator, shown in Table II.

Table I Results from analysis of fuel and sludge samples from MV "Probo Gull", with untreated and homogenised fuel

Sample no.		*F10000 9566*	*F10000 9567*	*N10000 1123*	*F10000 9571*	*F10000 9572*	*N10000 1127*
Date		10.11.00	10.11.00	09.11.00	11.11.00	11.11.00	10.11.00
Sample point		Before separator	After separator	Sludge sample	Before separator	After separator	Sludge sample
Operating condition		R	R	R	H1+H2	H1+H2	H1+H2
Density, 15 °C	kg/m³	990.0	989.9		990.0	990.0	
Viscosity, 50 °C	mm/s²	382.3	381.9		380.4	378.9	
Water	% V/V	0.5	0.2		0.4	0.3	
Micro Carbon Residue	% m/m	16.47	16.33		16.18	16.55	
Sulphur	% m/m	3.75	3.79		3.80	3.82	
Ash	% m/m	0.03	0.03	2.10	0.03	0.03	1.20
Vanadium	mg/kg	69	70	70	69	71	40
Sodium	mg/kg	22	18	1100	23	22	580
Aluminium	mg/kg	12	6	2600	15	5	1500
Silicon	mg/kg	17	9	3800	20	8	2100
Iron	mg/kg	5	3	840	6	3	500
Nickel	mg/kg	19	19	40	20	20	30
Calcium	mg/kg	4	3	220	4	3	120
Magnesium	mg/kg	1	1	110	2	1	60
Lead	mg/kg	< 1	< 1	30	< 1	< 1	< 10
Zinc	mg/kg	1	2	70	2	1	40
Total sed. potential	% m/m	0.02	0.01		0.02	0.01	
Total sediment existent	% m/m	0.01	0.01		0.02	0.01	
Total sed. accelerated	% m/m	0.02	0.01		0.01	0.01	
Asphaltenes	% m/m	8.0	8.0		7.6	7.5	

Table II Results from analysis of fuel samples from MT "Berge Stavanger", with 0.8 % water and homogenised fuel

Sample no.		*F19900 7824*	*F19900 7825*
Sample point		*Before separator*	*After separator*
Operating condition		H1	H1
Density, 15 °C	kg/m³	956.5	956.5
Viscosity, 50 °C	mm/s²	186.8	189.1
Water	% V/V	0.8	0.7
Micro Carbon Residue	% m/m	8.5	8.6
Sulphur	% m/m	3.29	3.3
Ash	% m/m	0.01	0.01
Vanadium	mg/kg	34	34
Sodium	mg/kg	6	6
Aluminium	mg/kg	< 1	2
Silicon	mg/kg	1	4
Iron	mg/kg	< 1	< 1
Nickel	mg/kg	9	9
Calcium	mg/kg	< 1	4
Magnesium	mg/kg	< 1	2
Lead	mg/kg	< 1	< 1
Zinc	mg/kg	< 1	< 1
Total sed. Potential	% m/m	< 0.01	< 0.01
Total sediment existent	% m/m	0.01	< 0.01
Total sed. Accelerated	% m/m	0.01	< 0.01
Pour point	°C	9	9
Asphaltenes	% m/m	2.5	2.5

As expected, the results clearly demonstrate the largely reduced capability in separating water when operating on homogenised/emulsified fuel. However, again due to very low content of other contaminants, the efficiency regarding other contaminants cannot be properly evaluated from these results.

The following conclusions might be drawn based on the fuel sample analysis from the case ships:

- For most of the fuels tested, the fuel content of contaminants was generally too low to establish exact values for the separator efficiency, hence comparison between untreated and homogenised fuel is unfair.
- For the fuels with higher content of contaminants, no significant changes in separator efficiency of cat. fines (Al/Si) is evidenced between untreated and homogenised fuel. However, the fuels content of water were fairly low.
- Special test with 1 % water injected upstream the homogeniser clearly indicated reduced capability of separating water when operating on homogenised/emulsified fuel.
- Further tests on fuels with high levels of contaminations are necessary to draw final conclusions regarding possible changes in separator efficiency when operating on homogenised fuel, such tests should also include fuels with high water content.

Improved combustion quality

In order to document possible improvements in combustion quality due to use of fuel homogenisers and water emulsion, the following parameters have been investigated:

- Specific fuel consumption
- Dynamic combustion pressure, rate of heat release
- Emission levels (NOx, THC, CO, smoke)
- Exhaust temperatures and cylinder liner temperatures
- Exhaust heat exchanger efficiency

Influence on specific fuel consumption

Figure 1 shows results from measurements onboard MV "Hual Trident" on voyage from Barcelona to Southampton. Measurements were performed during the following operation modes:
- Homogenised fuel (H1+H2)
- Reference, untreated fuel (R)
- Homogenised water emulsified fuel (H1+H2+W)

Each column is an average of several measurements in each operation mode.

The results imply that the fuel homogenisation and the actual water emulsion (ab. 5 % water) have no significant effect on fuel consumption. The dispersion of the values in each test mode was above the average difference shown in the figure. This result is confirmed from the other test ships.

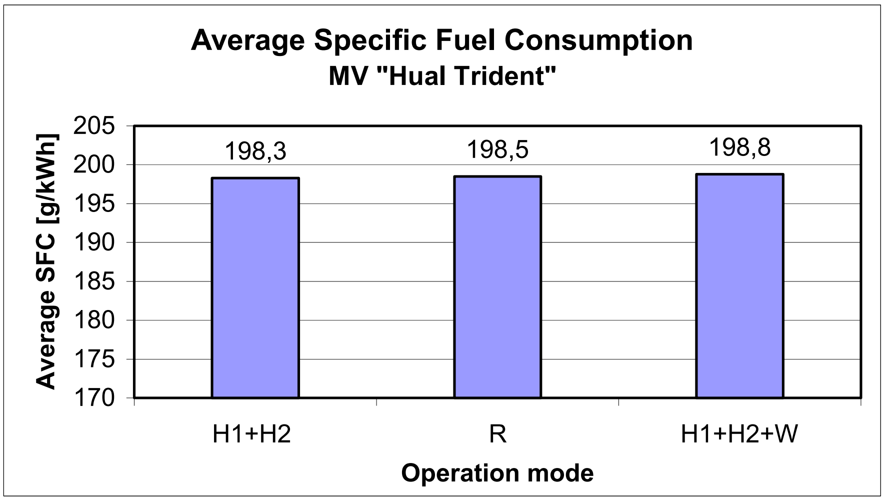

Figure 1: Average specific fuel consumption results from MV "Hual Trident", operation on homogenised (H1+H2), untreated reference (R), and homogenised water emulsified fuel (H1+H2+W)

Influence on dynamic cylinder pressure and rate of heat release

Any improvement in the engine combustion process, like reduction in ignition delay or accelerated combustion, always will be reflected in the dynamic cylinder pressure, and even clearer in the calculated rate of heat release. Investigation of these parameters was done as a supplement to the other measurements in order to substantiate possible effects of the fuel homogenisation. Figure 2 and 3 present results from the tests onboard MT "Berge Stavanger", reference condition on untreated fuel, R2, on homogenised fuel, H1+H2, and on homogenised water emulsified fuel (ab. 10 % water), H1+H2+W.

As comes forth, the diagrams for cylinder pressure and rate of heat release are identical between the reference case, R2, and the operation on homogenised fuel, H1+H2. Hence, the test evidence no significant change in the combustion process between untreated and homogenised fuel, this is also confirmed from the other test ships. However, when operating on homogenised water emulsified fuel, H1+H2+W, the ignition delay is slightly increased and the maximum cylinder pressure is reduced, but when the combustion starts the rate of heat release is improved compared to the case without water emulsion, and completion appears to be in the same range, about crank angle 395. This is in accordance with theory and earlier experience, and the reason for the lower NOx-emissions when operating on emulsified fuel.

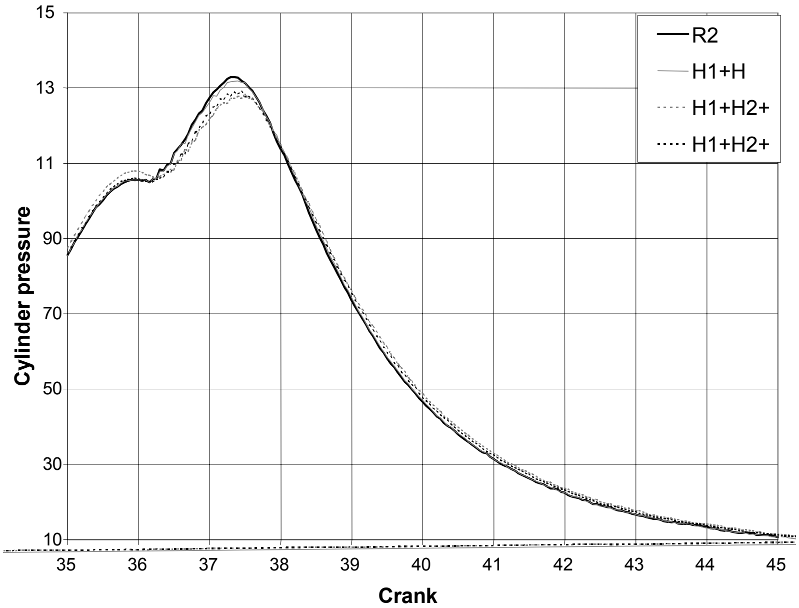

Figure 2: Dynamic cylinder pressure, MT "Berge Stavanger", from operation on untreated, homogenized and homogenized water emulsified fuel

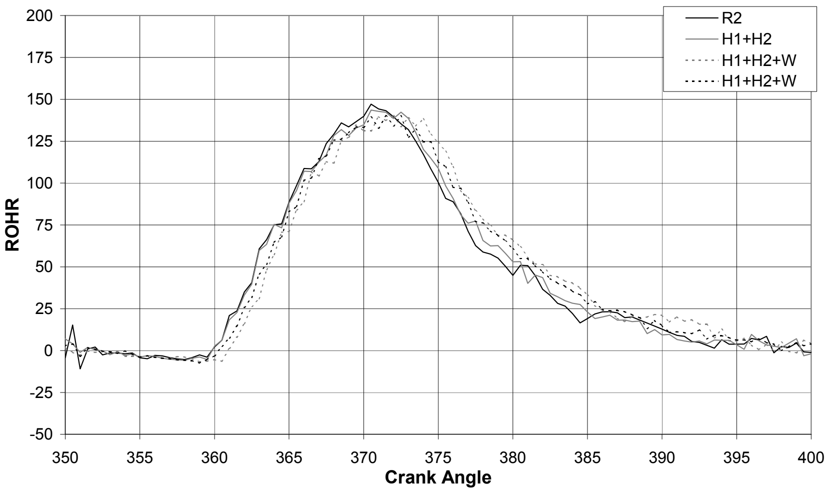

Figure 3: Calculated rate of heat release, MT "Berge Stavanger", from operation on untreated, homogenised and homogenised water emulsified fuel

Influence on emission levels

The performed tests also included exhaust gas measurements of NOx, CO, THC and smoke, as some homogeniser manufacturers claim that fuel homogenisation will reduce NOx formation during the combustion process.

Figure shows specific NOx-emissions from operation on various forms of fuel pre-treatment, adjusted according to ISO 8178-1 (earliest recorded data to the left, latest recorded data to the right).

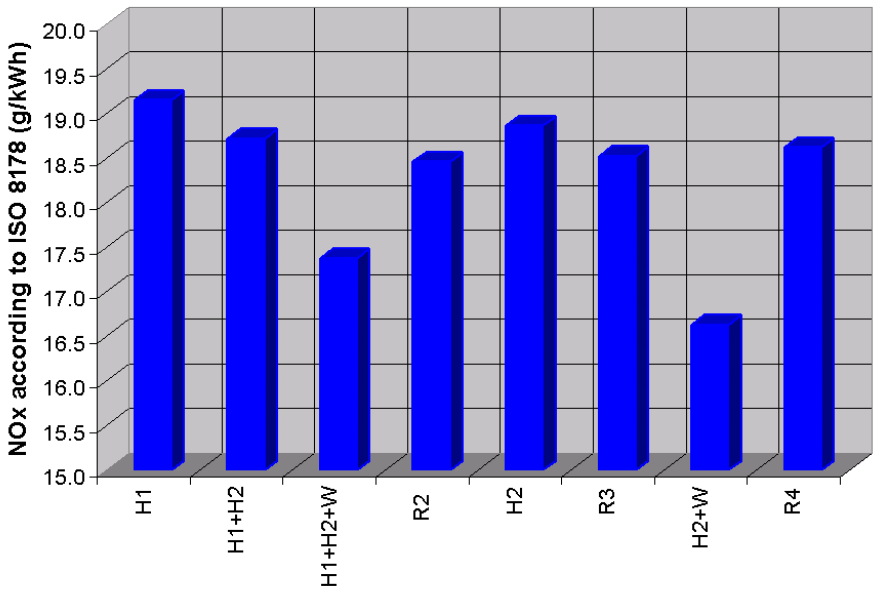

Figure 4: Specific NOx emissions from operation on various forms of fuel pre-treatment

- ✓ NOx emissions for the cases with untreated fuel varied between 18.5 and 18.6 g/kWh.
- ✓ NOx emissions for the cases with homogenised fuel varied between 18.7 and 19.1 g/kWh.
- ✓ NOx emissions for the cases with homogenised 10 % water emulsified fuel varied between 16.6 and 17.4 g/kWh.

The actual tests were done during a month voyage from Arabian Gulf to US, with corresponding variation in ambient conditions. The ambient conditions are parameters strongly influencing the NOx emission levels. Although the specific values have been adjusted according to ISO-8178-1, this correction factor is very general and does not give an accurate enough representation for the effects of ambient conditions on one particular engine. Therefore, only cases with similar ambient conditions are truly comparable. The ambient conditions for cases H2 and H1+H2 are fairly similar to cases R2 and R3, and the NOx emissions for these cases are well inside 0.5 g/kW, which with mentioned uncertainties should be seen as insignificant. Hence, based on performed tests no effects on the NOx emissions were recorded when operating on homogenised fuel.

The ambient conditions for the case H2+W are very similar to those of the reference conditions. The NOx emissions are reduced from 18.5 g/kWh to 16.6 g/kWh, which are about 10%, and as expected. A smaller reduction is obtained in case H1+H2+W, but this may be due to lower ambient temperature and hence lower water to dry air ratio. Hence, based on the performed tests it might be concluded that water emulsified fuel has the expected effect on reducing NOx emissions.

THC and CO emissions were also recorded for the same operating conditions as above. No correlation between emission level and operating condition was found, indicating that THC and CO emissions were not affected by homogenised or emulsified fuel. However, as with the NOx emissions, the THC/CO level are also strongly affected by the ambient conditions.

PERFORMANCE OF TBT-FREE ANTI-FOULING PAINT SYSTEMS

Ships travel faster through the water and consume less fuel when their hulls are clean and smooth, free from fouling organisms, such as barnacles, algae or molluscs. In the early days of sailing ships, lime and later arsenical and mercurial compounds and DDT were used to coat ships' hulls to act as anti-fouling systems. During the 1960s the chemicals industry developed efficacious and cost-effective paints using metallic compounds, in particular the organotin compound tributyltin (TBT). By the 1970s, most seagoing vessels had TBT painted on their hulls.

The harmful environmental effects of organotin compounds were recognized by IMO in 1990, when the Marine Environment Protection committee (MEPC) adopted a resolution which recommended that Governments adopt measures to eliminate the use of antifouling paint containing TBT.

On 5 October 2001, a diplomatic conference adopted the IMO convention on the control of harmful anti-fouling systems on ships by consensus. This convention states a global prohibition on the application of organotin compounds which act as biocides in anti-fouling systems on ships by 1 January 2003, and a complete prohibition on the presence of organotin compounds which act as biocides in antifouling systems on ships by 1 January 2008. However, to be legally binding it need to be ratified by at least 25 states, the combined merchant fleet of which constitute not less than 25% of the gross tonnage of the world's merchant shipping.

Many ship owners have for several years tested tin-free antifouling paint systems, both in form of test areas and for full hull bottoms, with varying success. Some ships have experienced severe fouling and speed loss. Hence, many ship owner advocate against the ban, and ask for more time and thorough documentation regarding the performance of alternative paint systems. And in the same way, most nations are reluctant to ratify the ban. This is the background for the initiative to this programme. The test programme is part of a research project called "Green Efforts for Existing Ships", operated and managed by the Norwegian Marine Technology Research Institute, MARINTEK. The project is funded by the Research Council of Norway and the Norwegian Shipowners' Association in addition to support from all participating partners.

The overall objective of this TBT-free anti-fouling paint test programme is to perform testing and establish documentation on performance of last generation tin-free antifouling paint systems, based on application of test patches on ships in normal operation. Ship owners participate by offering test ships and arrange for test areas. The composition of test ships should be sufficiently broad to reflect operational conditions for the world fleet both regarding trades, trading waters, speed, activity levels, docking intervals etc, also most demanding operational conditions for anti-fouling systems to be covered. All major suppliers of anti-fouling paint systems participate with their last generation products, designed for the actual ship and trade.

A joint industry test programme

As mentioned in the introduction all paint suppliers do continuous testing of their products, also by means of test patches on sailing ships, in agreement with respective ship owner. What is seen as unique with this specific test programme is the extent of test ships and test patches, and even more the broad participation from most parties influenced by the actual TBT ban, from ship owners and the Norwegian Shipowners' Association, from all major suppliers of anti-fouling paint, from classification as well as research laboratories. A total of twenty-two companies has signed a Joint Venture Agreement and are directly involved in the test programme activities.

This broad cooperation is invaluably important, both regarding the objectiveness of results as for an efficient spread of information. Prior to dry-docking of each test ship when the test patches are applied, a meeting between paint suppliers and ship superintendent is arranged, for common data regarding the specific test ship, operation profile, docking interval as well as planning and positioning of test patches. Based on this each paint supplier make up his test patch specification, which are gathered by the programme manager before distribution between all involved parties. As the paint suppliers are fairly familiar with their competitor's products, this procedure ascertains that the paint systems specified are consistent with the test ship operation profile. With contribution from all partners the programme has elaborated standard report forms for paint application, divers inspection and final inspection in dry-dock, to ascertain comparable documentation between test ships. All paint suppliers are represented in dry-dock during the test patch application, and each fill in application data for his test patch together with comments regarding the quality of paint application as well as other relevant information. In addition wet paint samples are collected from all applied paint systems, for analysis of tin content and possible fingerprint test. All this data are gathered in an "Application Report" for each test ship, and is important for an objective evaluation at the end of the test period.

The wide participation of ship owners is similarly important to satisfy the programme objectives. The ship owner group represents a wide range of ship types, trades, trading waters, and docking interval, hence enable the selection of a set of test ships representative for the world fleet. As pr today test patches are applied on a total of sixteen test ships, and the first applied test patches have accumulated more than two years operation. The ship owners also play an active role in planning and follow up during test patch application, and further by performing intermediate in-water inspection as agreed between the partners.

DNV Section for Materials and Inspection Technology participates as specialist in Coating and Material Protection. They are prime responsible for all laboratory activities, wet sample analysis, spinning disc tests etc., in addition for all final dry-dock inspections and evaluation of obtained results.

Test programme discription

The project was formally established in June 2000, and the first test ship, the car carrier MV "Tancred" from Wallenius Wilhelmsen was dry-docked the following month and applied test patches. Since then test patches have been applied on a total of sixteen test ships. Of these fourteen has patches of last generation self-polishing (SP) anti-fouling paint systems, the last two has patches with biocide-free paint systems. The total test ship programme is presented in figure 5, also indicating the wide range of ship types/trades, when docked and applied patches and planned docking interval, as well as planned finalized test period.

Ship type	Ship owner	Ship name	Dock	Period	00	01	02	03	04	05	06	07
Car carrier	Wilhelmsen	Tancred	7/00	36								
Gas carrier	Bergesen	Helice	8/00	60								
Chemical	Stolt Nielsen	Stolt Egret	9/00	30								
Shuttle tank	Knutsen OAS	Vigdis Knutsen	10/00	36								
Chemical	StoltNielsen	Stolt Sapphire	10/00	60								
Tanker	Red Band	Knock Muir	12/00	60								
Open hatch	Billabong	Star Harmonia	12/00	36								
Coastal express	TFDS	Kong Harald	1/01	36								
Coastal express	TFDS	Polarlys	1/01	36								
Cruise ferry	Color Line	Kronprins Harald	1/01	24								
Cruise vessel	Red Band	Black Watch	3/01	24								
OBO carrier	Frontline	Front Breaker	4/01	60								
Bulk carrier	Høegh	SG Prosperity	8/01	60								
Supply	Farstad	Far Fosna	11/01	30								
LPG Carrier	Bergesen d.y.	Berge Ragnhild	2/02	30								
General Cargo	Grieg Billabong	Star Fuji	3/02	30								
	Klaveness	NN										

Figure 5: The total test ship programme

The participating paint suppliers goes forth from figure 6, also presenting which products are tested. The SP products all utilize copper-oxide as biocide, but in other respects the composition and properties between them are quite different compared to the existing TBT based technologies, which are fairly common in formulation. The biocide-free products are all based on silicone technology, but as Ameron at the time being doesn't have an available product in this category, they do not have test patches on those two test ships. The programme is still active in search of a third test ship for biocide-free systems.

Suppliers	SP-Products	Biocide-free Products
Jotun Paints/NOF Kansai Marine Coatings	SeaQuantum	Everclean
International Coatings/ Nippon Paint	Intersmooth Ecoloflex	Intersleek
Hempel's Marine Paints A/S	GLOBIC SP-ECO	HEMPASIL SP-EED
Star Marine Coating/ Chugoku Marine Paints	Sea Grandprix	Sea Grandprix ECO-Speed
Sigma Coatings	AlphaGen 20	Sigmaglide LSE
Ameron International	ABC#3	

Figure 6: Tested products by suppliers

The test patch areas are located mid-ship, for ships with single side loading arrangement preferably on the seaward side to reduce mechanical damages. Vertically the test patches goes from the bilge keel to the deep load line, and the horizontal width of each test patch is 3 – 5 m. For the best relative comparison between the test patches the sequence of test patches between the products are altered systematically from one test ship to the next. Figure 7 shows test patch layout during application on MV "Star Harmonia" from Grieg International/Billabong.

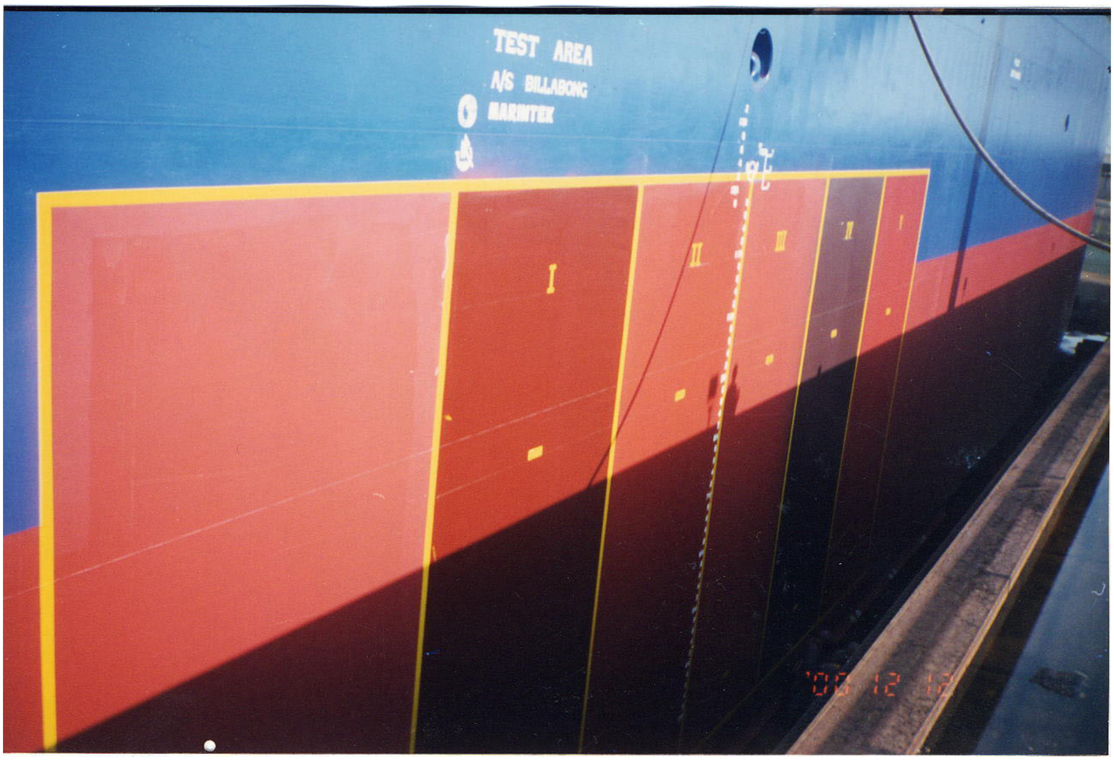

Figure 7: Test patch layout, MV "Star Harmonia"

The surface preparation of the total hull is decided by the ship owner. Several test ships is full blasted to steel and applied new anti-corrosive and TBT-free anti-fouling, in those cases one of the suppliers are main, the remainder have test patches as described above. However, the most common practice is still to do touch up of damaged areas and apply new TBT based anti fouling on top of existing paint system, eventually with a sealer in between. In those cases the surface preparation of the test patch zone are decided between the ship superintendent and representatives from the suppliers dependent on surface condition of existing coating. Even conditions for the total test area has been weighted, and for most ships in this category the upper half of the test area has been blasted to steel, then applied new anti-corrosive and possible sealer before specified anti-fouling test patches.

Since five of the ships have docking intervals of five years, the final results will not be available before the last ship has ended its test period by the end of year 2006. However, some early results valid for ships with the shortest docking periods are planned May 2003. Further an intermediate report is scheduled to December 2004, covering all but the 60 months paint systems.

DISCUSSIONS AND CONCLUSIONS

By the project execution the importance and superiority of the actual kind of joint industry research is clearly recognized. All results might not be of significant scientific importance, though of great value for the participating parties. First of all it is recognized as an highly efficient way of jointly generation and transfer of knowledge, experience and technology, important for a cost-efficient adoption of coming environmental legislation.