ECOSPEED®

SHIP HULL PERFORMANCE TECHNOLOGY

Contents

Total Protection

The rudder of M/V Elisabeth Russ before Ecospeed was applied in 2004, showing heavy cavitation damage.

The rudder of M/V Elisabeth Russ in drydock in 2011. No further cavitation damage has occurred in the intervening 7 years.

Ships have been sailing for up to nine years (and counting) with Ecospeed without having to replace the coating on their rudders or having to opt for important and costly steel repairs.

Ecospeed can be applied on a rudder at a very low cost, especially compared with the large drydock costs. It will give a rudder supreme protection against cavitation and corrosion damage for the rest of the vessel's service life.

Ecospeed is a really fast and easy way of keeping a rudder's performance at maximum efficiency at all times.

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Ecospeed rudder applications in Bahrain, Canada and China

Over the last few months the rudders of three container vessels, a roro vessel and a cruise vessel from a number of different fleets, were coated with the Ecospeed glassflake surface treated composite (STC) at shipyards in China, Canada and Bahrain. The coating ensures lasting protection against cavitation damage for the rudders of these vessels for the remainder of their service life.

The decision to use Ecospeed was made by the shipowners after cavitation damage had appeared on the rudders of their vessels. Ecospeed will prevent similar damage from occurring again. Most of these owners are returning customers for Ecospeed and so they had experienced firsthand the benefits of an Ecospeed coating.

Ecospeed gives a very thorough and lasting defense against cavitation and corrosion damage for a ship hull's entire service life. The coating equally provides the rudder (and/or the entire underwater hull) with an impenetrable protective layer while its flexibility enables absorption of the forces that are produced by cavitation. This prevents the damage normally caused by this phenomenon. Without proper protection against cavitation and the resulting erosion and corrosion damage, the financial consequences can be severe.

Application of first layer of Ecospeed on rudder in Shangai.

Ecospeed is applied in only two, identical layers.

Tests in a flow channel, sponsored by the French Ministry of Defense and carried out in Grenoble, have confirmed that Ecospeed performs extremely well under severe cavitation. These tests were divided into six stages during which the coating was exposed to an increasing pressure drop, leading to a growing cavitation force. Even after the last stage no erosion was present on the test

An Ecospeed application can easily be adapted to the yard's schedule.

Ecospeed will protect the rudder against cavitation and corrosion damage.

Ecospeed will protect the rudder for the remainder of the vessel's service life.

Both rudders of a cruise vessel had suffered severe cavitation damage prior to the Ecospeed application.

patch coated with Ecospeed.

By removing the existing paint layers and applying Ecospeed on the rudder we can break the never ending cycle of painting, suffering damage, having to perform extensive repairs in drydock followed by a full repainting, again and again.

With an Ecospeed application no repaint will be needed during drydocking. Ecospeed is guaranteed for ten years. At most, minor touch-ups will be needed. Planning the maintenance of the vessel's stern area therefore becomes much easier. The smoothness attained by the coating also provides optimum hydrodynamic conditions for rudders to operate at maximum efficiency. The ship's performance remains stable and the owner's investment is secured. ■

After surface preparation, Ecospeed is applied in two identical layers.

Only minor touch-ups will be needed during future drydockings.

Ecospeed can protect a rudder against the forces produced by cavitation.

Oceantide – A yacht's hull protected with Ecospeed

When Henk and Annet Brautigam bought the yacht *Oceantide* in 2006, they knew that the hull needed some work. They decided that rather than patch it up and have an even rougher bottom to their yacht, they would take it back to bare steel and start from scratch. The yard at Dordrecht where the work on the yacht was being done recommended Ecospeed. In 2007 they had the hull grit blasted and Ecospeed was applied. It has been going strong ever since and they sail with the comfortable feeling of having a really safe, thoroughly well-protected hull under them.

The yacht Oceantide.

The *Oceantide* was built in 1982 at Burlington Boat Works in Ventura, California, by the owner of that yard, who designed her to sail to Alaska, hence the fireplace and chimney, very useful on chilly nights in an Alaskan summer when it's not worth running the central heating. Henk Brautigam, who is a partially retired yacht captain himself, and his wife, Annet, bought the yacht in Florida and had her shipped to Rotterdam, Holland where they live.

The *Oceantide* is a 76 ft. (23.3m) LOA, 18' 2" (5.5m) beam trawler, long range cruiser, with a 6.6' (2m) draft and a 26' (7.9m) airdraft. She displaces 90 tons, has a range of 4,000 nautical miles and a cruising speed of 9 - 11 knots. Powered by two Caterpillar 3306TI, 190hp, 4600 hrs diesel engines, the *Oceantide* has a fuel capacity of 4,500 gallons, a 1,500 gallon water tank and a 1,000 gallon holding tank, plus a desalination plant. The *Oceantide* has three staterooms, sleeping six, and crew quarters which sleep two. The classic salon has oak paneling and parquet flooring. The staterooms are also oak with oak tongue and groove flooring. Four heads including a day head with marble counters and floor and a master head with full-sized tub and shower. All in all, the *Oceantide* is a very comfortable, livable, well made, well kept and beautifully appointed yacht.

The Oceantide at Varend.

Protecting the hull

"The bottom, previously coated with antifouling paint, was rough and needed to be treated," explains Henk. "We knew when we bought it

The Oceantide's well-equipped wheel house.

The Oceantide's engine room.

The saloon.

that there were some problems but we had it tested and it was found to be quite sound. We wanted to have it totally clean and get it as new, so we had it grit blasted in Dordrecht. They suggested we either use one of the epoxy systems or Ecospeed. I hadn't heard of Ecospeed. They told us it was very hard, very tough and you don't need to put antifouling on it. It was a bit more expensive but came with a ten-year warranty which was a big advantage. We stay tied up to the quay all through the winter and the bottom fouls. My big question was, could we handle the fouling."

"We decided to take the risk and put it on," says Henk. "Now it's on and it's very good."

The entire bottom, rudders and stabilizers were painted with two coats

The Oceantide out of the water just before the hull was grit blasted and Ecospeed was applied.

Detail of the condition of the hull in 2007 prior to Ecospeed application.

Newly applied Ecospeed on the hull.

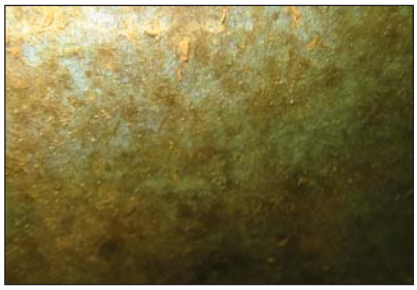
of Ecospeed, a total thickness of about 1000 microns.

Annet confirms their satisfaction with the Ecospeed hull coating system protecting the *Oceantide's* hull: "Ecospeed feels very safe. You have the idea that it has a second hull or something like that because of the glass in the coating."

Cleaning the hull

Ecospeed can be cleaned by pressure washing with the yacht out of the water but the best way to clean it is using mechanical brush equipment in the hands of a diver. The reason for this is that the in-water cleaning, by a combination of the brush's abrasiveness and the lubrication of the water, smooths the coating a little bit more each time which results in a hydrodynamically smoother surface which is harder to foul.

In 2011 the Brautigams brought the *Oceantide* to the dock next to the Hydrex headquarters in Antwerp where Hydrex divers cleaned it using proprietary cleaning equipment. The hull was easily cleaned and found to be in perfect condition.



The fouled hull prior to in-water cleaning, 2011.

For sale

The Brautigams are basically sailors. They came from sailing yachts and plan to go back to sailing yachts. The *Oceantide* was an interlude and now they are ready to go back to sail.

They feel that the Ecospeed coating on the yacht's hull will add value to the yacht to anyone who is familiar with the glassflake coating system and they know that their investment was protected in the best possible way for the time they have had it.

"Going with Ecospeed was a gamble for us," says Henk. "We evaluated it ourselves and decided to go with it. Now we have no regrets at all. It was the right decision."

They have shown quite clearly that

Ecospeed coated hull after cleaning. The coating is completely intact after four years of sailing in Baltic and other waters and being tied up for months on end.

Ecospeed is not only the answer to non-toxic underwater hull protection and fouling control on ships, but is just as workable on yachts and smaller craft. ■

Annet and Henk Brautigam on the Oceantide in Rotterdam in June 2012.

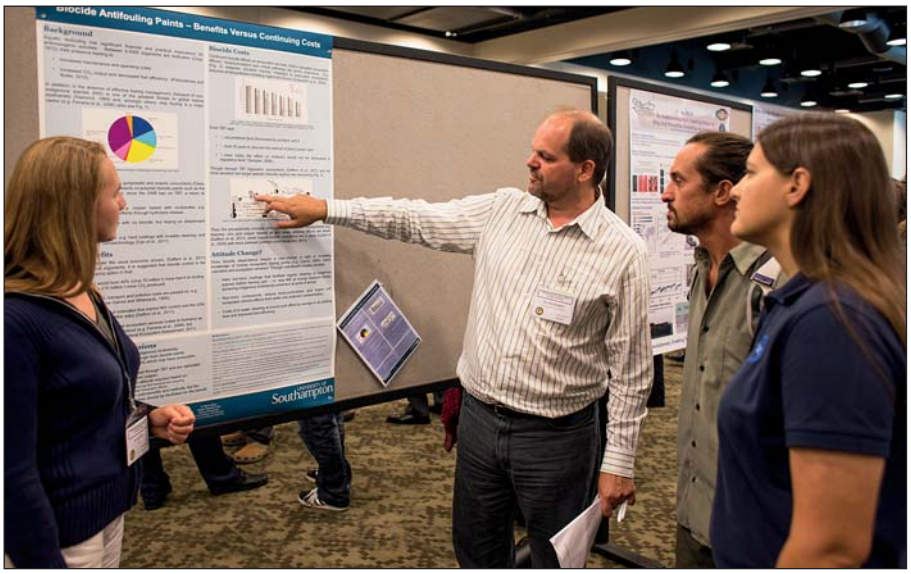
ICMCF 2012 Seattle

The 16th International Congress on Marine Corrosion and Fouling (ICMCF) was held between the 24th and the 28th of June this year at the Conference Center at Convention Place in downtown Seattle, Washington, USA. The ICMCF is a biennial congress organized on behalf of the Comité International Permanent pour la Recherche sur la Préservation des Matériaux en Milieu Marin (COIPM), an international committee for research into material protection in the marine environment.

Some 300 individuals attended the event which had a very busy and full agenda. Talks were on every imaginable subject with any bearing whatsoever on marine corrosion, biofouling, hull efficiency, antifouling systems, biocides, invasive species, emissions, legislation regarding toxic substances and so on. Some of the talks covered the background and existing solutions or approaches in these various disciplines. Others were descriptions of pure research, new coatings or cleaning equipment under development, environmental matters, reports of experiments and pilot projects.

The Congress Chairman was Steve McElvany of the US Office of Naval Research, an organization responsible for funding a fair proportion of the research described in the various talks and presentation. The 2010-2012 Chair of the COIPM was Geoff Swain. This was his last year as Chair and he handed the baton over to Serena Teo of the National University of Singapore. Since the 2014 ICMCF will be held in Singapore, this is a sensible choice. Geoff Swain himself gave an excellent presentation entitled, "Antifouling coatings: a drydock perspective," sharing the experience he and his team at the Florida Institute of Technology have had with biocidal and fouling release coatings used on Royal Caribbean Cruise Lines ships in drydock and illustrating the relationship between coating type, coating roughness, biofouling, surface preparation, coating

David Phillips, Hydrex Communications Exec, delivers a presentation on an alternative, non-toxic approach to eliminating the spread of invasive aquatic species.



During the first poster session, Dr. Simon Bray explains his poster presentation on biocide antifouling paints and their environmental effects to two of Dr. Geoff Swain's team at FIT, Emily Ralston and Abe Stephens. Dr. Ilse Steyl on left.

application, drydock capabilities, ship operational schedule and fuel consumption. He showed an enlightening selection of photos of ships with AF and FR coatings in various conditions.

But choosing one or two presentations to describe is futile. There were four plenary talks, 114 presentations and 100 posters shown in two sessions. The subject matter was incredibly wide ranging.

Hydrex was well-represented at the Congress. David Phillips, Communications Executive, Dr. Simon Bray, environmental consultant for Hydrex and Dr. Ilse Steyl, currently on a project for Hydrex to carry out research on sediment contamination were all present for the entire event.

David Phillips gave a presentation entitled, "Eliminating Hull-Borne Aquatic Invasive Species – An Alternative, Practical Approach," which made a case for a non-biocidal Surface Treated Composite and in-water cleaning as the only environmentally safe technology for preventing the spread of invasive aquatic species. Its blatant anti-biocide approach created something of a stir amongst the proponents of conventional, biocidal coatings.

Dr. Simon Bray presented a poster entitled, "Biocide Antifouling Paints – Benefits vs. Continuing Environmental Costs," in which he showed clearly the detrimental effects of continued use of biocides such as copper oxides, Diuron, Irgarol and others, on the environment and the food chain.

With the number of presentations and posters which extolled the value and virtues of biocides and the importance of using them and lamented what they considered to be the excessive strictness of legislators and legislation restricting the use of biocides and denying them full rein, the Hydrex presentation and the poster joined with excellent talks from the Port of San Diego's Karen Holman and Stephanie Bauer, Leigh Johnson and Carolynn Culver of the University of California, Dr. Dan Rittschof of Duke University, and a number of others concerned with the environmental aspects, were important in presenting a balance and showcasing the importance of minimizing the effects of antifouling on the environment.

Perhaps the most entertaining and instructive talk of the entire congress was by Professor Hans-Curt Flemming of the University of Duisburg-Essen entitled, "Biofouling – Unsolved Problems, Insufficient Approaches and Some Light at the Horizon," in which he reiterated a memorable quote" "KILLING IS NOT CLEANING," referring specifically to biofouling. His talk was light but incisive and impactful.

Mike Schultz of the U.S. Naval Academy in Annapolis, chaired the session on Ship Hydrodynamics and Energy Efficiency, which included a highly informative presentation by Daniel Kane of Propulsion Dynamics entitled, "Evaluating Hull Fouling on Ship Performance: Underwater Photos in Connection with Speed/Fuel Consumption Analysis."

These are of course just a handful out of a very large number of presentations, reports and posters which all together made the 16th ICMCF a great success.

The new Chair for 2014 is Serena Teo of the Tropical marine Science Institute at the National University of Singapore who is looking forward to a great gathering of members of the scientific, legislative and industry communities who share an interest in the development of materials and methods for preventing marine corrosion and biofouling.

The full list of abstract summaries for the 16th ICMCF can be found at http://www.icmcf.org/uploads/ICMCF_Abstract_Summaries_FINAL.pdf and further information about the event is available at www.icmcf.org. ■

Biocide Antifouling Paints – Benefits Versus Continuing Costs

Background

Aquatic biofouling has significant financial and practical implications for anthropogenic activities. Between 4-5000 organisms are biofoulers (Crisp, 1972); their presence leading to:

- Increased maintenance and operating costs;
- Increased CO_2 output and decreased fuel efficiency (Poloczanska and Butler, 2010).

In addition, in the absence of effective fouling management, transport of non-indigenous species (NIS) is one of the greatest threats to global marine biodiversity (Diamond, 1989) and, amongst others, ship fouling is a major vector (e.g. Ferreria *et al*., 2006) (also see Fig. 1).

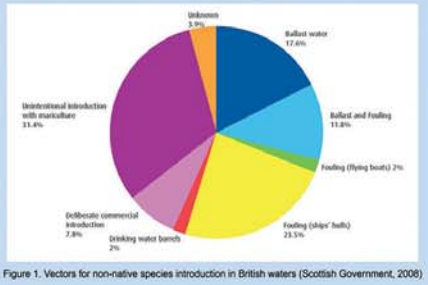


Figure 1. Vectors for non-native species introduction in British waters (Scottish Government, 2008)

Control

From a background of oil, sulphur, gunpowder and arsenic concoctions (Clare, 1995), fouling control gravitated towards co-polymer biocide paints such as the highly toxic tributyltin (TBT). But, since the 2008 ban on TBT, a return to alternatives based largely on:

- Self Polishing Coatings (e.g. copper based with co-biocides e.g. triazene) which have toxic effects through hydrolysis release;
- Fouling Release Coatings with no biocide, but relying on detachment with vessel movement;
- Non-biocidal alternatives: e.g. hard coatings with in-water cleaning; and experimental e.g. nanotechnology (Cao *et al*., 2011).

Biocide Benefits

In simplified terms, under the usual economic drivers, (Daffern *et al*., 2011) coupled with ecological arguments, it is suggested that biocide control is the best commercial shipping option in that:

- The world fleet would burn 40% (circa 70 million t) more fuel if no fouling control with circa 210 million t more CO_2 produced;
- With limited control, transport and pollution costs are passed on, e.g. pollution taxation (see Garrod and Whitmarsh, 1995);
- Limited data for NIS, but estimated that marine NIS control cost the USA $138 billion annually (1990s data) (Daffern *et al*., 2011);
- The impact of NIS on marine ecosystem services (value to humans) as yet undervalued or not understood (e.g. Ferreria *et al*., 2006), but recognised as a threat (UK National Ecosystem Assessment, 2011).

Biocide Costs

Continued biocide effects on ecosystem services, trophic cascades (ecosystem effects), bioaccumulation and critical pathways are poorly understood. E.g. (Fig. 2) seagrass (*Zostera marina*), important to associated ecosystems, acquires photosynthesis inhibiting Irgarol and Diuron (Chesworth *et al*., 2004).

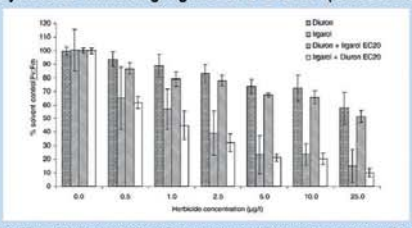


Figure 2. Effects of Diuron, Irgarol 1051, on *Zostera marina* growth (expressed as a percentage of the solvent control) after 10 days exposure. Herbicide concentration 0.0 µg/l +/- 1sd. (modified from Chesworth *et al*., 2004).

Even TBT was:

- *"...not predicted* [but] *discovered by accident*; and it
- "...*took 35 years to discover the method of* [toxic] *action"* and
- *"...even today the effect on molluscs would not be discovered in regulatory tests"* (Sumpter, 2009).

Though through TBT legislation, ecosystems (Daffern *et al*., 2011) and the most sensitive non-target species (*Nucella lapillus*) are recovering (Fig. 3).

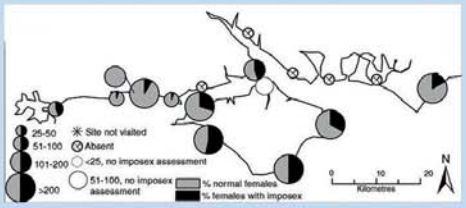


Figure 3. *Nucella lapillus* population and imposex recovery in the Solent region, UK, 2007-2008. (Modified from Bray *et al*., 2011).

Thus, the precautionary principle should be applied to TBT replacements (e.g. triazene, zinc and copper based) as and when adverse effects are shown (Daffern *et al*., 2011); some copper-biocide restrictions are in place (Carson *et al*., 2009) with more planned (Johnson and Fernandez, 2011).

Attitude Change?

Does biocide dependence require a step-change in light of increasing knowledge of marine ecosystem tipping points (e.g. Cairns, 2004), trophic cascades and ecosystem services? Through cost-benefit models consider:

- Hard non-toxic coatings that facilitate regular cleaning of indigenous species before leaving port – i.e. stop NIS at source harbours thereby achieving indigenous biodiversity protection at ports of arrival;
- Non-toxic compounds reduce bioaccumulation and trophic and ecosystem service effects from water and sediment contamination;
- Costs of in-water cleaning at source port offset by savings in dry docking fees and improved fuel efficiency.

Conclusions

- Biofouling affects human activities and indigenous biodiversity;
- At present, control is mostly achieved through toxic biocide paints;
- This saves fuel, reduces CO_2 and limits NIS which may have ecosystem services implications;
- But, biocide impacts have been recognised through TBT and are replicated through alternatives such as triazenes and copper;
- Is this appropriate or is a step change in attitude required based on:
  - Regular cleaning of non-toxic material thus reducing NIS transport and stopping biocide impacts on non-target species and wider ecosystem effects;
- This approach needs more research on cost-benefits and methods, but the transition from toxic to non-toxic approaches should be facilitated for the benefit of marine systems and humans.

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A .pdf of Dr. Simon Bray's poster can be found online: http://www.hydrex.be/upload/news/pdfs/ICMF_poster.pdf

Supreme Rudder Protection

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