

Barnacle bill just got higher

The IMO decision to phase out TBT hull antifouling paints has posed a major challenge for marine paint suppliers: achieving similar performance at comparable cost for tin-free coatings

The stir caused by the recent decision to ban the use of organotin compounds in hull antifouling coatings on commercial ships gives the misleading impression that environmental concerns about these so-called tributyltins (TBTs) are a relatively recent phenomenon. Yet, soon after these paints were introduced back in the 1970s, governments began to worry about the toxicity of TBT leaching from the paint and its impact on surrounding marine life.

A lesser evil

On their introduction, TBTs were seen as a major step forward in environmental protection, because the primary antifouling biocides in use at the time were DDT, phenyl mercury, pentachlorophenol, organolead, copper and arsenic compounds. Compared to most of these substances, tributyltin derivatives possessed low mammalian toxicity but were highly active from a microbiological and fungicidal point of view. Because they were very toxic to molluscs and an effective biocide for a wide range of marine fouling organisms, organotin compounds were incorporated into most antifouling paints from the early 1970s onwards.

The development of self-polishing copolymer (SPC) paints, with the TBT biocide chemically bonded throughout the coating, in the mid-1970s, ensured the success of the new technology. Because the technique allowed a slow, uniform release of the biocide to the surface, SPC paints proved to be more effective at preventing fouling and reducing frictional drag. Surveys carried out in the 1980s indicated that over 92 per cent of TBT SPC-painted ships showed low fouling, while only 36 per cent of ships painted with tin-free antifoulants were rated as satisfactory.

The comparatively low cost of TBT SPC paints further reinforced the market success of this technology.

Small boat ban

Paint manufacturers estimate that some 70-80 per cent of the current world ocean-going fleet is painted with TBT SPC-based paints. However, despite the rapid, initial success of the SPC paints, concerns about the toxicity of TBTs persisted. Following a series of scientific studies conducted in the early 1980s, several countries decided to regulate the application of TBT-based paints. In 1988 the US banned the application of TBT paints on non-aluminium vessels less than 25 metres in length and restricted the release rate of TBT. This effectively prohibited the use of free-association paints, i.e. those in which the TBT is not chemically bound in the paint matrix, thus allowing an uncontrolled release. Japan and many countries in Europe enacted similar restrictions following the US action.

Although the bans on the use of TBT paints on pleasure craft were effective in securing some reduction in general levels of TBT concentrations in the marine environment, the maritime community felt that this was not enough. The new IMO convention adopted in October 2001 calling for the eventual phase-out of TBT hull antifouling coatings (see accompanying summary of the convention's requirements) is the end-result of this global push for tin-free paint for all commercial vessel hulls.

Equal performance

Fouling, or the growth of barnacles, seaweed, tubeworms and other organisms on ship bottoms, produces a roughness that increases turbulent flow, acoustic noise, drag and fuel consumption. Tests have shown that a one-thousandth of a centimetre

average increase in hull roughness can result in a 1 per cent increase in fuel consumption.

The challenge for the suppliers of marine paint is to provide the industry with tin-free antifouling coatings whose performance approaches that of TBT paint at a reasonable cost. TBT SPCs have a solid track record of providing an effective working life in excess of 60 months, while many of the tin-free products developed in the past have only lasted 36 months or less. Furthermore, many of the tin-free paints are two to three times as expensive as TBT coatings.

However, the writing has been on the wall for TBTs for some time now, and a number of alternatives to TBT antifouling have been developed and put into service, namely copper-based SPCs and conventional free-association paints. TBT-free SPCs can provide useful lives of 60 months, whereas ablative and conventional paints perform well up to a maximum of 36 months.

The optimum choice of antifouling system for a vessel depends on several factors, including the type of vessel, trading pattern, days spent in port, voyage length, drydocking intervals and environmental legislation.

Conventional antifouling

The conventional free-association type of biocide-leaching antifouling paints possess no chemical binding between paint matrix and biocide. The main biocide in conventional paints is copper, either as metal or in compounds, while there are a variety of chemicals that are used as co-biocides.

The effective life of soluble matrix paints is generally short, i.e. approximately 12 months. For insoluble matrices it is a bit longer, say 24 months, but near the end of the biocide release phase, the drop-off in performance is rapid. Also, the porous film left after the biocides have leached out constitutes a very weak substrate for any new coatings and a sealer coat is normally required.

Ablative paints consist of two components - the paint matrix and the biocide. Seawater movement against a ship's hull polishes off the matrix and the biocide leaches out. However, because the biocide is not evenly dispersed in the paint matrix, the leaching rate will not be constant. Also, the solubility of the paint matrix and the incorporated biocides may not be identical.

Self-polishing antifouling

Self-polishing (SPC) antifouling paints are based on a copolymer binder. The copolymer hydrolyses in seawater at a constant linear rate, releasing the biocides, and the binder becomes water soluble as soon as enough of the copolymer has been hydrolysed.

SPC paint with copolymer-bound TBT has been the leading hull antifouling for many years, but over the past decade, with environmental fears about such paint growing, work has been underway to replace TBT by copper or zinc in order to create the first TBT-free, self-polishing paints. This technology, using copper or zinc as the chemically bound main biocides and only a restricted number of co-biocides, has now been developed and a number of TBT-free SPC paint systems are available. Most of the major marine paint companies market TBT-free SPC systems, the top-of-the-range products including the Intersmooth Ecoloflex 460 series from International Paint, Chugoku's Sea Grandprix 1000, Ameron's ABC#3, Hempel's Globic SP-Eco 819 series, AlphaGen 10/20/50 from Sigma and Sea Quantum Plus from Jotun, the latter exclusively licensed from BASF NOF Coatings Company. All these systems are marketed with effective working lives of up to 60 months.

Biocide-free antifouling

Hull antifouling technology has not stopped there. To avoid any leaching of biocides into the sea, several paint companies have developed antifouling coatings which contain no active ingredients. Instead, the surfaces of these systems are configured

such that the physical properties of the paint inhibit the attachment of fouling organisms.

Silicones have been used as one such material, based on the same technology that provides the non-stick surfaces common in home cooking utensils. Although silicones have only limited success in preventing foulings from taking hold, the adhesion between the fouling and the coating is weak. As a result, marine organisms can be easily removed, and will even fall off if the ship speed is in excess of 15 knots. Although the lifespan of silicones, in theory, is unlimited, such coatings come with a high price tag compared to the alternatives. There are a number of products on the market, including the Biocleen series from Chugoku, Hempasil from Hempel, Biox from Kansai and International Paint's Intersleek series. Such paints tend to be specified for smaller ships.

Biocide-free antifouling also include a self-polishing type, which utilises a non-toxic compound in place of the copolymer-bound biocide, and the so-called fibrecoats based on short, electrostatically charged fibres applied in a dense pattern to a layer of epoxy glue. These latter specialist systems have not yet achieved any notable commercial success.

Bulk resin production

Akzo Nobel, parent of International Paint, is seeking to control costs through economies of scale. Some €4 million has been invested to expand tin-free resin production at its Felling facility in the UK, more specifically, the manufacture of the patented copper acrylate polymers used in Intersmooth Ecoloflex SPC products. Start-up of the new production facility is planned for this spring.

"We are number one in marine coatings worldwide," says Leif Darner, general manager of the Marine and Protective Coatings Business Unit. "This investment in copper acrylate resin production is a key part of our strategy to further strengthen this position. Intersmooth Ecoloflex SPC is an integral part of our range of non-TBT antifouling coatings."

Chugoku is seeking to streamline the whole process of ship hull painting with the introduction of a new all-purpose primer coat - Bannoh 500 - which can be used throughout the ship, including on the underwater hull in conjunction with its Sea Grandprix tin-free, self-polishing antifouling paint. Bannoh 500 has been launched under the CIT 21 hull coating system banner and is a wear-resistant, all-purpose epoxy primer which can be applied all over the ship at the same time. It contains no tar and, as it does not bleed into the outer coating, a variety of outer coats can be applied over it.

Two-pronged push from Hempel

In addition to its Globic SP Eco series of self-polishing tin-free paints, which was introduced in early 2000 and has already been applied to the hulls of over 700 ships, Hempel is promoting its Hempasil Speed silicone-based, biocide-free paints. Hempel points out that this latter coating is ideal for passenger vessels with frequent drydocking intervals since, except for areas with mechanical damage, only washing is necessary to remove marine organisms. To date, the hulls of 92 vessels have been coated with the new Hempasil product

As to the future, even though the exact entry into force date of the new Antifouling Convention is still up in the air, the leading coating suppliers have said they will phase out production of their TBT paints by January 1, 2003. "Environmental legislation will only get tougher, and this will impact paint suppliers and the products they offer," points out Kim Scheibel, newbuilding manager at Hempel's Marine Paints.

"Within five years expect more restrictions on volatile organic compounds and more focus on silicone-based antifoulants. It is difficult to predict further ahead but new restrictions on the active ingredients in hull paints within the next 10 years would not

come as a surprise. Will a ban on copper be next? IMO and the US Environmental Protection Agency will be the final judges."