TRIBUTYLIN ANTI-FOULING PAINTS

IT'S PRESENT EFECTS AND ALTERNATIVES

BY

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ABSTRACT

The wonder find of the early 1960's was when Tributyltin (TBT) was added to anti-fouling paints to give ships a relatively five year foul free hull. Gradually but consistently this has become a major focus of attention of the International Maritime Organization to ban its further use altogether once for all in view of its devastating effects of marine aquatic life. About four years ago i.e. 1998 was declared the year of clean oceans by the UNO. Considerable efforts and research study are underway to find viable alternatives for a friendly anti-fouling paint devoid of TBT, some of which are outlined in the article.

Introduction

A few years ago, at the London headquarters of the International Maritime Organization (IMO), the Marine Environment Protection Committee (MEPC) met and agreed to develop terms of reference for a working group that will draft regulations to phase out and eventually prohibit organotin-based self-polishing co-polymer anti-fouling paints such as Tributyltin (TBT).

Adverse effects of TBT

It was not till the early 1960s when TBT was added to anti-fouling paints that the benefits of having a relatively foul-free hull were reaped. As this technology matured, cost fell providing ships owners with an efficacious cost-effective anti-fouling paints that had by the mid 1970s been painted on the hulls of almost every sea-going vessel in the world. But that euphoria was not to last long. The effect that TBT and other organoametallic compounds have on the marine environment was first identified at the end of the 1980s/beginning 1990s by the MEPC. The MEPC strongly recommended that member States of the IMO adopt measures to eliminate TBT containing anti-fouling on non-aluminum hull vessels of less than 25m in length. The use of organotin compound paints with a leaching rate of more than a 4mg per cm^2 of TBT per day was also prohibited. The MPEC working group was also to prepare a draft assembly resolution for adoption at the 21st IMO Assembly in 1999 urging member States to encourage the use of alternatives to organotin anti-fouling systems pending the entry into force of a mandatory instrument. This will of course require the adoption of a new annex to MARPOL 73/78.

The MEPC agreement follows the decisions made at the fourth International Conference on the protection of the North Sea which took place in 1997. The fruits of this meeting, the Esojerg declaration stipulated that participating ministers are agreed on taking unilateral action within the IMO to ultimately phase out the use of TBT on all ships world wide. But if no satisfactory progress is made then ministers will consider imposing a ban on the use of TBT on ships trading within the North Sea at least that fly the North Sea State flags.

The deathblow to the use of TBT was however, delivered by the Marine Conservation Society's report on anti-fouling paints and TBT. The report stated that the effects of extreme and non-specific toxicity of organotin compounds on the entire marine ecological system are devastating. The report added that these types of self-polishing co-polymers are specifically designed to leach a certain quantity of toxins into the sea so as to destroy all aquatic organisms attached to the ship's hull with the ultimate commercial aim of reducing fouling of the hull. Studies have shown that these chemicals particularly TBT which can be toxic even at minute concentrations (1-2 µg/ltre), are evident in fresh and salt water, sediments, the blubber, liver and kidney of marine mammals and have even resulted in the thickening of oyster shells.

The collapse of the commercial shellfish population in Arachon Bay, France way back in 1982, after a total tin level 110mg/kg was registered, prompted many States to act and enforce some restrictions on the use of TBT. The malformation and retarded growth of oysters first observed in France had gradually spread to all oyster habitats along the Atlantic coast, resulting in massive financial loss to farmers. The Marine Conservation Society also believed that organtins may act concurrently with other pollutants and that the combination of TBT and other pollutants has resulted in the death of 18,000 Harbour Seals and dolphins. A study undertaken in Japan has found that TBT and other organtin-based products are evident in the livers of 18 species of dolphins, whales and seals from Pacific and Asian waters.

How effective have existing TBT restrictions been?

TBT restrictions were implemented only after the shellfish population collapsed in Arachon Bay, France in 1982. Following the French initiative and after successful lobbying from the Marine Conservative Society, England, the USA, New Zealand, Australia, Norway, and Hong Kong followed suit and banned the use of TBT on all vessels under 25M in length, on equipment for fish or shellfish tanning and any submerged appliance. Developing countries however, are still taking their time to catch up and have been able to implement only a few controls.

In 1980 the worldwide use of organotin was estimated at 30,000 tons and TBT constituted 3,000 tons. Yet productions of organotin compounds continued to rise and the current figures point out to 35,000 tons. This wide spread use of TBT as a marine anti-foulant has helped to increase tin concentration in wash down yards, dry-docks and slipways thereby suggesting that hull cleaning is a primary major source of TBT pollution.

The restriction imposed by countries independent of each other has to some extent reduced the concentration of TBT contamination in coastal waters. For example, oyster farming has returned to France and Britain. But in some docks, harbours and marinas where shipping is intense, especially in the USA where a high level of TBT is still applied to aluminum hulls, the level of concentrate can exceed 100 µg/litre tar. This is higher than the 2 µg/litre set by the UK Environmental Quality Standard and the 10 µg/litre set by Netherlands. This is associated with an increased TBT level in fresh and sea water, sediment which is often re-admitted into the sea through dredging and biota and the proximity to marinas, enclosed water and poor tidal flushing. In a Plymouth Marina in 1986, TBT levels of 1µg per litre were found whereas samples taken from a marina in the estuary of the river Dart with good tidal flushing saw levels of less than 0.2µg per litre.

It is widely acknowledged that though the restrictions imposed on vessels less than 25m in length has reduced TBT concentration in areas used by pleasure boats. But due to large vessels not being covered by the 1990 IMO resolutions, only a small

reduction has been noted in the vicinity of docks and harbours since the beginning of 1990s.

Countries such as Japan, Sweden, and New Zealand, have already banned TBT anti-fouling paint. At the MEPC 41, Greece expressed concern surrounding the economic effects of a total TBT ban on small ships in coastal operations. Japan, which is already committed to TBT free anti-fouling, felt that the use of alternatives could easily lead to fuel consumption increase of around 3% to be borne by the ship owners. Nonetheless, IMO recommendations on a global scale regarding the ban of TBT anti-fouling paint will go a long way in minimizing the environmentally catastrophic effects associated with organometallic compounds in anti-fouling paints.

Other alternative anti-fouling paints devoid of TBT

It is well known that vessel efficiency and anti-fouling performance are inextricably interrelated and although anti-fouling requirements differ in coastal waters and deep seas, the key requirements are:

- Excellent resistance to a wide range of fouling organisms.
- A good polishing rate suitable for either coastal or deep-sea vessels.
- Control of average hull roughness.
- Cost effectiveness.
- High efficiency.

Some argue that the TBT free anti-fouling paints are less effective and moreover, promote an increase in fuel consumption and CO_2 emissions. In the past, some interested lobbies even claimed that there was no viable alternatives to TBT based anti-fouling systems that can last up to five years without dry-docking. This has been found totally incorrect due to recent development of certain substitutes now available commercially. According to some ship owners operating in the Baltic and North Sea, an average vessel goes three years between dry-docking and only 10% actually need a five-year dry-docking system. There are today TBT free systems available commercially claiming to last three years but ship managers have been reluctant to use them. In Sweden, where the use of TBT is more restricted than in the rest of Europe, a study on the consequences on the restricted use of organotin compounds on the Swedish shipping industry has found that a majority of ship yards and ship-owners who used the latest non TBT paints have experienced insignificant problems – economic or otherwise. This is indeed encouraging for future development

Some of the alternative anti-fouling paints devoid of TBT are:

Controlled Depletion Polymer (CDP)

CDP is a tributyl free option though there are problems. Firstly, CDP anti-fouling uses copper oxide and other booster biocides to increase efficiency against algae and requires the physical erosion of the paint film before it releases the biocides. This means that a thick leached layer can form on the paint surface relatively quickly and as the rate of paint film erosion is not controlled, it is unable to keep up with the leached layer. Also, once in dry-dock, the build up of leach layer proves difficult to remove when devoid of moisture, creating difficulties through hull roughening when re-painting. At best, the CDP system can be considered to be really effective up to three years.

Copper Acrylate Polymers (CAP)

CAP on the other hand uses a similar type of acrylic backbone polymer to that used in TBT SPC systems but these also pose problems. CAP undergo hydrolysis in seawater thereby reducing their efficiency in self-polishing as they do not possess the necessary chemical control mechanism. This means that once the paint has been hydrolyzed, CAP systems will act in the same way as CDPs. Nippon Paints of Japan has developed a copper acrylate polymer that promises to achieve the same characteristics as TBT containing SPCs without any drawbacks up to three years.

Foul Release Technology

Probably the most Eco-friendly commercially available alternative is the foul release non-stick ship system. This is a non-biocide, self-polishing silicon based system, which provides an extremely smooth, low energy surface to the hull, reducing the ship clinging ability of aquatic organisms. Although organisms can still settle on the coating when static, they are washed off by the time a vessel reaches 20 knots.

The foul release concept although still in its infancy is inevitably more expensive than other fouling systems and at the moment is only economically viable as a replacement for TBT SPC systems on vessels that can exploit its speed enhancing and fuel consumption characteristics. It must not be forgotten however, that TBT SPC coatings when first introduced in the 1960s were twice as expensive than the products they sought to replace. So as the technology matures and as TBT restrictions come into force, the cost of silicon based system is expected to gradually fall and become more competitive.

International's foul release coating INTERSLEEK_has already been tested and proved on a number of high speed, high activity ferrys. Hempel's release coating HEMPASIL SPEED is undergoing sea trials and is expected to offer sustained anti-fouling performance for five to ten years.

Also, Jotun's Marine Coatings patented a self-polishing tin free foul release system called SEA QUANTUM based on a newly developed silyl polymer formula, which is expected to offer anti-fouling protection up to 60 months.

Recently, a Massachusetts based company has developed an anti-fouling system that is capable of providing a film of hydrogen peroxide to make the ship's hull less inviting with the object of reducing fouling within the first few inches of the hull.

Conclusion

One thing that stands out from the above is that the foul release technology is expected to be the most environmentally friendly and a sound method of foul prevention. It has prompted a number of companies engaged in the business of ship's hull protection to venture into this new tin-free technology of anti-fouling paints. It is understood that the IMO has recently cleared the proposal of banning TBT anti-fouling with effect from the year 2003 and a total ban of its use on all ships to be achieved by the year 2008. It is hoped that the new substitutes shall prove their worth in time to come. Till then, the ocean shall mercifully and graciously continue to accept whatever the man made technology has to offer.