

Antifouling performance at the level you choose



Antifouling coatings – maintaining smooth, clean underwater hulls

Antifouling coatings make a valuable contribution to the sustained operational efficiency of commercial and naval ships by maintaining smooth, clean underwater hulls.

This is achieved by the release of active ingredients (or biocides) which prevent the settlement of marine fouling organisms. The success of this process depends upon the type of biocide used, the biocide release mechanism and the polishing and smoothing action of the coatings technology employed.

Antifouling coatings can additionally deliver through-life benefits for the shipowner, including extended drydocking intervals and reduced time in drydock, lower future maintenance costs and fewer emissions due to lower fuel consumption.

Antifouling can also minimise the potential for translocation of invasive marine species, a growing concern for governments worldwide and international bodies such as the IMO.

Hull Roughness

Roughness of the underwater hull increases frictional resistance.

Increased resistance means that in order to e.g. maintain schedules there will be a corresponding increase in ships' power, fuel consumption, cost and emissions. Frictional resistance is just one of the four main forces that have to be overcome to efficiently move a ship through water:

- Air resistance
- Eddy-making resistance
- Wave-making resistance
- Frictional resistance

In practice air resistance is generally quite minimal, accounting for a few percent of the total resistance, usually less than 5%. Eddy-making resistance is also quite small and in a well-designed hull is negligible. Wave-making resistance is extremely important and increases dramatically with speed. Frictional resistance is that part of the resistance created by the effect of the hull "rubbing" against the fluid it is moving through and as the roughness of the surface increases the greater the frictional resistance.

There are two main types of roughness on ships' hulls: physical roughness, due to surface defects such as coatings build up, coatings cracking,

detachment and corrosion and biological roughness, due to fouling.

Fouling

There are over 4,000 different types of fouling species. They are generally classified as:

- Slime fouling
- Weed fouling
- Shell fouling.

A heavily fouled ship can increase resistance by over 40%. The intensity of fouling and the fouling challenge presented is influenced by:

- Light: required for photosynthesis, decreases with depth along with productivity and so presents a low fouling challenge in deep waters but a high challenge in shallow waters.
- Temperature: varies from 35°C in the tropics to -2°C at the poles, with a world average of 4°C; exothermic life is driven by temperature; low temperatures prolong growth but do not necessarily prevent it.
- Oxygen: surface concentration decreases with decreasing pressure; the overall concentration decreases with pressure and depth.
- Mineral nutrients: nitrogen is usually

the limiting nutrient, and iron is also important; high levels of nutrients can cause growth spurts and algal blooms. Pollution can also be a factor, particularly in port.

- Salinity: varies in open ocean (30-35 practical salinity units - psu), brackish waters (<30 psu) and fresh water (<0.5 psu). Organisms vary regarding salt tolerance.
- Vessel speed and activity: fouling organisms attach more easily on slow moving, low activity vessels.

Fouling organisms vary around the world in their type, composition and intensity. Commercial shipping has to contend with all types of fouling challenge. Biocidal antifoulings must therefore have a wide spectrum of activity.

Market Drivers

The main driver dictating development in biocidal antifouling technology is legislation. This addresses biocide use and registration, substance registration, solvent emissions and product stewardship.

Biocide registration already exists in numerous countries, for example in the USA via the Environmental Protection Agency and in the EU

through the Biocidal Products Directive (BPD). Strict control is exercised over which biocides are allowed and their release rates into the environment. Compliance is a legal requirement.

The IMO's AFS (International Maritime Organisation's Antifouling System Convention) provides a global mechanism for removing substances of concern from the market.

It is interesting to note that International Paint was the first coatings company to voluntarily withdraw tributyltin (TBT) based biocidal antifoulings ahead of the IMO's global ban in 2003.

All components in paint have been subject to substance registration for many years (ToSCA (Toxic Substances Control Act), EINECS (European Inventory of Existing Commercial Chemical Substances) and NICNAS (National Industrial Chemicals Notification and Assessment Scheme), for example. In the EU the introduction in 2007 of REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) will replace the EINECS program and is expected to cause the loss of around 30% of current paint raw materials. Knock-on

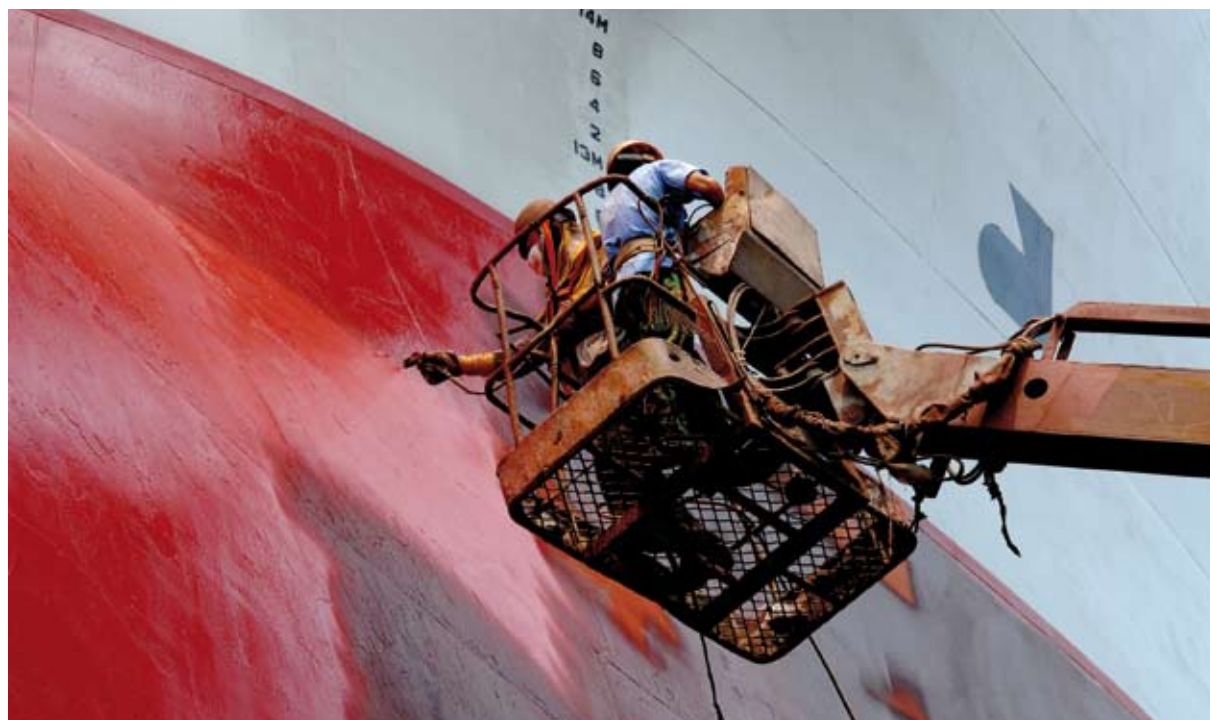
effects are anticipated in the USA and Far East as authorities contemplate following the EU.

Substances of concern, though not regulated against, can be unilaterally removed through Product Stewardship initiatives.

Solvent emissions have been covered by VOC/VOHAP (Volatile Organic Compounds/Volatile Organic Hazardous Air Pollutant) legislation in the USA for many years and, more recently, by the EU SED (Solvent Emissions Directive) and CAFÉ (Clean Air for Europe) legislation. Taiwan has a VOC 'tax', and Korean shipyards now have VOC targets.

Other drivers of biocidal antifouling development include raw material costs with copper and zinc prices continuing to fluctuate. Oil derivatives costs have also escalated with paint products being affected through increased polymer and solvent costs.

All of these drivers stimulate common worldwide development programmes to create products that are high in solids and compliant with global and local biocidal restrictions, local raw material restrictions and in-house Product Stewardship initiatives;



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while maintaining performance and operator benefits in fuel and emissions reductions through fouling prevention and/or hull smoothing.

Biocidal Antifouling Technology

There are three main biocidal fouling control technologies currently available – self polishing copolymer (SPC) antifouling, self polishing antifouling and controlled depletion polymer (CDP) antifouling. All have differing effects on vessel hull roughness and differing abilities to control fouling. The different technologies are determined by the biocide delivery mechanism employed.

1. Self polishing copolymers (SPCs) undergo a reaction (hydrolysis) with sea water to make it soluble. The result is thinner leached layers with excellent control of biocide release.

Water migrates into the paint film and the surface reacts with sea water ions and becomes soluble. The surface then dissolves, releasing biocides and film thickness is lost. Reaction/solution continues with the film getting thinner through polishing. The coating stops working when it has all polished away.

There are three main self polishing copolymer (SPC) technologies currently available: copper acrylate, zinc acrylate and silyl acrylate.

Copper acrylate self polishing copolymer (SPC) technology delivers controlled chemical dissolution of the paint film, underwriting a capability for long drydocking intervals of up to 60 months with inherent self smoothing. Predictable polishing rates enable specifications to be tailored to the ship type and operational profile. Thin leached layers foster simple cleaning and re-coating at maintenance and repair drydockings.

2. In rosin-based CDP technology, water migrates into the paint film while dissolved rosin and biocides leach into the sea. Insolubles are left in the leached layer. The dissolution rate continuously declines and the leached layer grows until it is too thick to allow further water penetration.

Rosin has some disadvantages: it is a



Intersmooth®7460HS SPC application on a 306,000 dwt tanker

brittle material and can cause cracking and detachment; it reacts with oxygen so must be immersed relatively quickly and it does not prevent water entering the antifouling paint film.

A slow dissolution of the paint film in sea water is associated with CDP technology, similar to the way that a bar of soap disintegrates when left in water. This dissolution gradually slows down over time due to the formation of insoluble materials at the surface.

The maximum effective life of a CDP coating is typically 36 months on the underwater sides but it can extend up to 60 months on the flat bottom of the ship. Leached layers can become thick, increasing roughness, and care is required in removing as much leached layer as possible before overcoating at an M&R drydocking.

CDPs are described by a number of perhaps confusing terms, including hydration, ablative, eroding, polishing, self polishing and ion exchange antifouling. They are characterised by the use of rosin, natural or synthetic, or rosin derivatives (ASTM D-1542), higher volume solids (55-60%) and thick leached layers. Film integrity is generally poor and re-blasting is necessary after 10 years' service.

CDP antifouling is not as effective as self polishing copolymer (SPC) systems and their generally thick leached layers limit performance and negatively affect re-coatability. Such

products, however, have a place as the lowest cost per square metre 'value for money' antifouling and are suitable for use in low fouling areas or for ships with short drydocking intervals.

3. Self polishing antifouling technology functions via a mixture of hydrolysis and hydration mechanisms combining self polishing copolymer (SPC) acrylic polymers with a certain amount of rosin. Performance and price are mid-way between the rosin-based CDP and acrylic SPC products, with a maximum service life of five years.

International Paint's antifouling range exploits all three technologies to meet specific performance, legislative and budget requirements.

Biocidal Product Range

International Paint has supported the shipping industry with pioneering antifouling technology since introducing its first antifouling in 1881. Numerous subsequent developments include the first self polishing copolymer (SPC) antifouling in 1974.

In September 2010, International Paint improved and expanded its range of biocidal antifouling coatings. The enhanced line up now includes higher volume solids products, meaning reduced coats per scheme, lower levels of overspray and reduced VOC emissions. The new range will help ship owners, operators and ship yards

meet the challenges of fluctuating fuel costs and increasing environmental pressures by delivering a full range of operational cost, environment and in-service performance benefits.

The range features the highest-performing self polishing copolymer antifouling, Intersmooth®SPC; the economical option Interspeed®; and a blend of both technologies in the new Interswift® products.

Leading the way is the renowned Intersmooth®7460HS SPC and Intersmooth®7465HS SPC, true, pure hydrolysing self polishing copolymer antifoulings for deep-sea vessels featuring high volume solids and low VOCs. Patented copper acrylate technology delivers controlled chemical dissolution of the paint film, which ensures continued smoothing over long drydocking intervals. Predictable polishing enables specifications to be tailored to specific ship types and operational profiles, while thin leached layers allow simple cleaning and recoating at drydockings.

Intersmooth®7460HS SPC and Intersmooth®7465HS SPC provide fouling control for up to 60 months and share in the proven track record of Intersmooth®SPC on over 15,000 vessels worldwide. The alternative Intersmooth®360 SPC and Intersmooth®365 SPC variants are specially designed for coastal vessels.

New Interspeed®6400 and Interspeed®6200 have been developed from proven controlled depletion polymer (CDP) based Interspeed® technology, which has been successfully applied to over 11,000 vessels. These products provide an economical choice for up to 36 months in service.

New Interswift®6800HS, developed from the proven self polishing Interswift® technology, is a high volume solids, low VOC blend of copper acrylate self polishing copolymer (SPC) technology and rosin based CDP technology. Providing up to 60 months fouling control in service, performance lies between the high performance self polishing copolymer (SPC) antifoulings and the



Intersmooth®7465HS SPC: maintaining good antifouling cosmetic appearance during fitting out

more economical CDP antifoulings.

Also available is Interswift®455FB, a product designed for the unique fouling challenge experienced on flat bottom areas.

As well as combining technologies in a single product, a new 'Advanced Duplex System' utilising both Intersmooth® and Interswift® products provides high performance, cost effective fouling control options.

Support

A global network of over 800 technical service representatives is available to offer advice to shipyards and operators/owners on International Paint products.

In service product performance can be predicted and then assessed using the company's 'Dataplan' system. An antifouling performance rating can be calculated from analysis of the in-docking condition of a ship. The type, severity and extent of any fouling present in conjunction with the trading pattern, operational profile and drydocking interval are all considered.

The 'Dataplan' system provides the shipping industry with the world's most comprehensive record of coating application and performance for newbuildings and drydockings.

Heavy investment in antifouling research and development is

committed to meet customer needs in a continually changing commercial and regulatory environment.

Underlining that commitment, International Paint's network of marine R&D centres across Asia, Europe and America was recently strengthened by a new worldwide marine antifouling product development laboratory in Singapore. The advanced facility is staffed by 20 specialist chemists with the latest resources for measuring and assessing biocidal antifouling performance.

SPC (Self Polishing Copolymer)

- Best antifouling performance
- Good film properties
- Polishing control
- Self-smoothing
- Thin leached layer
- Control of biocide release

Self polishing antifouling

- Good antifouling performance
- Good film properties
- High volume solids content
- Polishing control
- Surface tolerant
- Control of biocide release

CDP (rosin)

- Economical antifouling control
- High volume solids content
- Surface tolerant