Anti-fouling protection on a ship's hull: evaluation of recent developments and formulation of innovative alternatives

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Marine fouling, or the growth of marine organisms on fully or partly submerged structures, is an unwanted phenomenon in the marine industry. Bio fouling will increase the hydrodynamic drag of ships, causing an increased fuel consumption, promote the corrosion of the metallic structures and trigger undesired transport of invasive species (IMO and the environment 2009, 2009). The impact is economic as well as environmental. More fuel consumption is synonym for more CO2 and other detrimental emissions, corrosion entails coating and the introduction of toxic substances in the sea and air and the transport of hitch-hikers: non-indigenous species towards locations without natural enemies will harm the local delights of the marine environment.

In 2001 the IMO adopted the "International Convention on the Control of Harmful Anti-Fouling Systems on Ships". This convention entered into force 17 September 2008 and prohibited the use of harmful organotins in anti-fouling paints used on ships. A mechanism was established to prevent the future use of other potential harmful substances in anti-fouling systems. The ban on organotins confronted the marine industry with a major challenge. TBT's (TriButylTin) have a negative impact on the marine biotope but till today no equally efficient, harmless, substance has been found. The search for an efficient, economic and ecological friendly novel anti-fouling paint is high on the agenda of IMO, governments, paint producers, ship owners and environmental organizations.

All major marine coating producers bring to the market very similar products. Broadly speaking, the present hull anti-fouling systems focus on the following three generic types of AF-coating: firstly, hard coatings, usually biocide-free vinyl esters, reinforced with glass platelets. In actual fact this is not a real anti-fouling coating since fouling will appear over time but it resists mechanical cleaning, even with hard brushes, exceptionally well. Secondly, we have a whole range of soft/smooth paints, often based on silicones or fluoropolymers, rendering the hull surface so slippery that latching onto becomes difficult. Basically, this type of coating cleans itself by means of the speed of the ship, the organisms with little adhesion will flush of easily. Finally, the most popular type of fouling protection, have a toxic additive incorporated in the topcoat. Predominantly these additives are copper based products reinforced with booster biocides. Three different techniques are being used to release these toxins in a more or less controlled way. The most primitive system, dating from the 50's, consist out of a soluble matrix, in general colophony mixed with copper, arsenic, zinc, mercury or iron oxides. A few years later, the binder became non-soluble, acrylic resins, vinyl resins or chlorinated rubber polymers were being used together with copper and zinc oxides with or without organometallic compounds. Presently mainly self-polishing copolymers are being used whereby biocides are leached under a controlled manner. While sailing, the paint abrades and constantly a new layer of coating, mixed with zinc- or copper oxides emerges.

Each of the above described AF-coatings has a very specific and limited field of application. Selecting the correct coating for a specific ship is far from self-evident. Important differences do exist within each coating type, dependent on the manufacturer. Unfortunately, no real objective means of comparing these products exists, neither on performance nor on ecological impact.

The aim of this project is to establish an impartial test-protocol and build a platform for testing AF-coatings in a statically and dynamically manner. With knowledge of type, composition and performance of the anti-fouling paints tested we can advise the ship owners in an objective way and evaluate the ecological impact of a paint through a well-founded life cycle analysis.

Hitchhiking across the world's oceans: biofouling and introduced species

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Biofouling and introduced species are one of the causes of a changing biodiversity in the marine environment. In this talk I will address the topic of hull fouling and introduced species i.e. species introduced by human activities beyond their native range into new areas. In their new habitat, such species pose a threat to native biodiversity because they may alter local communities, and have unwanted economic effects. Hence the introduction of non-indigenous species is recognized as a major threat to the marine environment, and, for example tackled in EU legislation such as the MSFD.

Shipping, with ballast water and hull fouling, is an important vector for species introductions into the marine environment and since the dawn of maritime transport hull fouling has remained an everlasting nuisance, not only because it reduces the ships' speed and clogs intakes and pipes, it also impacts marine biodiversity, for, as biofouling, species are transported all over the world's oceans and introduced into areas beyond their natural distribution.

While ballast water is being tackled in various legislations and regulations, hull fouling remains an important cause of introductions, especially since the ban of the very effective anti-fouling agent TBT (Tributyltin). During the past decades, the chances for species to survive their journey and ultimately to colonise areas beyond their natural distribution has greatly increased, because maritime transport has become increasingly faster and more intense. Moreover, the permanent establishment of migrants is aided by the growing availability of artificial hard substrata in coastal areas and climate change. Barnacles (Cirripedia), probably the most common fouling organisms, are a good illustration of the ongoing changes as many species have nowadays established populations far beyond their original distribution.