



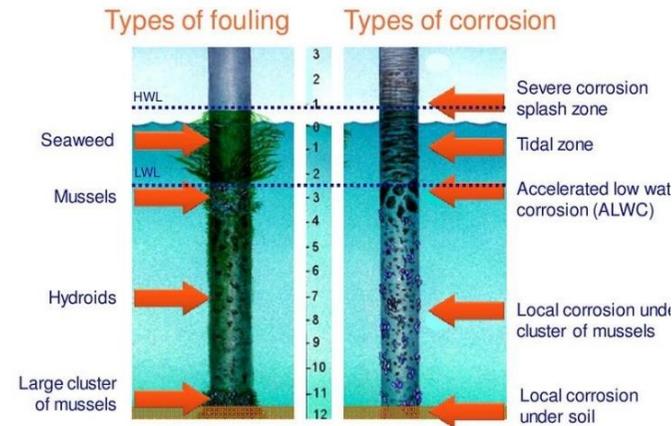
## OFFSHORE STRUCTURES

### ANTI-FOULING PAINT VS. FOULING RELEASE COATING FILM

<b>What is fouling?</b>	Fouling is an unwanted growth of biological material described as microfouling and macrofouling. Microfouling refers to the formation of biofilm and adhesion to the surface, and macrofouling refers to the attachment of organisms such as barnacles, diatoms and seaweed to produce a fouling community on a surface immersed in water.
<b>Why do you need anti-fouling systems?</b>	<p><b>Offshore structures:</b> An average growth of 5–10 cm increases the structural load by about 5.5 to 11.5% necessitating the periodical mechanical removal (divers or ROV), which appears to be the solution so far, for fixed offshore structures. This process is cost intensive and is a structural weakening process.</p> <p>In future particular attention needs to be addressed to floating foundations and an anchor chains due to the weight of the bio-fouling and its impacts on stability and loads.</p> <p><b>Vessel:</b> bottoms not protected by anti-fouling systems may gather 150 kg of fouling per square metre in less than six months of being at sea. On a Very Large Crude Carrier with 40,000 m<sup>2</sup> underwater areas, this would add up to 6,000t of fouling.</p> <p><b>Anti-fouling systems:</b> Almost all the known preventative methods envisage use of toxicants. Their conventional application though is effective but have short life span. Even with the deployment of state-of-the-art fouling prevention technology, the fouling thickness deposited on foundations grows continuously, eventually causing stress induced corrosion and crack defects.</p>

**What can be caused by bio-fouling?**

Offshore wind turbine foundation  
Biofouling and corrosion phenomena



Microbiologically influenced corrosion (MIC)

Initiation and acceleration of corrosion due to the interaction between microbial activity and construction material.

Application: Offshore Structures



**How do anti-fouling systems save a wind park owner money?**

An effective anti-fouling system can save a wind park owner money in several ways:

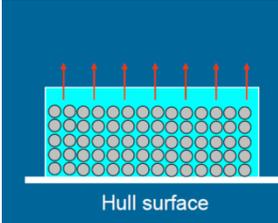
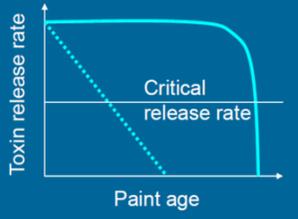
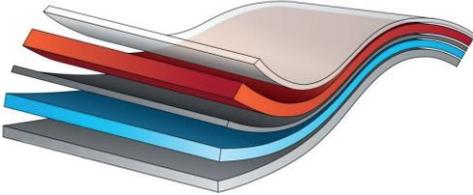
- Direct maintenance savings by keeping the structure free of fouling organisms
  - Less maintenance and repair work (e.g. painting, anti-corrosion measures)
  - Extended maintenance and service interval
- Ensuring the service life of the wind turbine

<p><b>What are technologically-advanced antifouling coatings?</b></p>	<p><b>Marine Paint Systems</b>, e.g. organotin-free self-polishing antifouling paint (<i>HEMPEL'S ANTIFOULING OCEANIC 8490K</i>).</p>	<p><b>Marine Film Coating Systems</b>, e.g. biocide-free fouling release coating film (<i>MacTac MacGlide</i>).</p>
<p><b>What are modern and effective working principles of anti-fouling coating systems?</b></p>	<p>The present working principle for most of the marine paint systems is based on a slow release of toxins (self-polishing coatings). Although the antifouling performance of such systems is good, the amount of toxin released may be quite substantial. The impact of such toxins on nature is negative. 150 000 tons of biocides are used across Europe each year, every square metre of applied paint contains around 15g of biocide - capable of contaminating 150 000 m<sup>3</sup> of water.</p> <p>Because of this impact, the use of organotins, such as tributyltin (TBT), on ship hulls was completely banned in 2001. In addition, the use of other toxins/biocides in antifouling coatings is restricted by law. Although the use of copper-based paints is not yet prohibited it may be banned in the near future. This drives the industry to evaluate new types of antifouling mechanisms.</p> <p>To get protection, the coating must have a sufficiently large leaching capacity with regard to the active toxic substances (high leaching rate). However, the release rate must not be too fast, as otherwise the service life of the coating would decrease, but also an unnecessarily large amount of biocide would be released into the environment.</p>	<p>An advanced and further developed effective marine coating system is the film coating system based on the concept of "Fouling Release".</p> <p>It consists of a high protective Fluoropolymer ("Silicone") layer and is totally free of biocides. The amphiphilic (both hydrophilic (water-loving, polar) and lipophilic (fat-loving)) property is unique in the market and prevents adhesion of a large scope of fouling. Their corrosion protection properties, the drag reduction due to the smooth surface and the easy application have a great impact on application and maintenance costs and operational efficiency.</p> <p>Fouling organisms have difficulty attaching themselves to hulls/structures and are washed off in flowing waters, like during tidal range and currents.</p> <p>The surface of the biocide-free fouling release coating remains smooth, water resistance falls.</p> <p>For offshore structures this results in reduced vulnerable areas (and reduced fuel consumption with regard to ships) for corrosion and force of the waves.</p>

<p><b>Are the coating systems using hazardous ingredients?</b></p>	<p>Marine Paint Systems, e.g. organotin-free self-polishing antifouling paint, e.g.:</p> <ul style="list-style-type: none"> <li>• <b>Copper</b> (I) oxide (&gt;25 % by weight)</li> <li>• Zinc ethylene-1,2-bis-dithiocarbamate (zineb) (&gt;5 % by weight)</li> <li>• 2-methylthio-4-tert.-butylamino- 6 -cyclo-propylamino-s-triazine (~1 % by weight)</li> </ul>	<p>Marine Film Coating Systems, e.g. <b>biocide-free</b> fouling release coating film:</p> <ul style="list-style-type: none"> <li>• Migration free fouling release</li> <li>• No hazardous ingredients</li> <li>• No volatile organic compounds (VOC)</li> <li>• Environmentally friendly</li> <li>• Applicable without health hazards</li> <li>• Eliminates overspray contamination</li> </ul>
<p><b>Are there any prevention measures to be considered during application of the coating systems?</b></p>	<p>Special instructions to be obtained before use: Avoid breathing vapors, spray or mists. Wear protective gloves/protective clothing/eye protection/face protection. Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Wash hands thoroughly after handling. May cause an allergic skin reaction.</p> 	<p>Special protective instructions and requirements with regard to the film coating system do not apply.</p> 



<p><b>Are any hazard statements made by coating system suppliers?</b></p>	<ul style="list-style-type: none"> <li>• Flammable liquid and vapor</li> <li>• Harmful if swallowed</li> <li>• Causes serious eye damage</li> <li>• Causes skin irritation</li> <li>• May cause an allergic skin reaction</li> <li>• Suspected of damaging the unborn child</li> <li>• Very toxic to aquatic life with long lasting effects</li> </ul>	<p>Materials, substances or mixtures are not hazardous and therefore do not need to be supplied with label to inform the employees and consumers about the risks.</p>
<p><b>What are the exposure controls/personal protection measures?</b></p>	<p>Sufficient ventilation by local exhaust ventilation needed and good general ventilation to keep the airborne concentrations of vapors or dust lowest possible and below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the workstation location.</p>	<p>The film coating system is free of VOC (volatile organic compounds), vapors or dusts. Therefore no specific ventilation is required.</p>
<p><b>What International Regulations /Certifications do the coating systems fulfil?</b></p>	<p>IMO Anti-fouling System Convention Compliant (AFS/CONF/26)</p>	<p>To be certified according to standards and customer´s requirements e.g.:          Certified according to DNV-GL-CP-0110          IMO Anti-fouling System Convention Compliant (AFS/CONF/26)</p>

<p><b>Is there any leaching of the coating substances?</b></p>	<p>The organotin compounds are chemically bonded to the polymer base of self-polishing paints. The biocide is released when seawater reacts with the surface layer of the paint. Once the surface layer is worn off, the reaction to release the biocide begins again with the next layer. Biocide release rates decrease exponentially with time and effective life is limited.</p>  	<ul style="list-style-type: none"> <li>• No leaching.</li> <li>• Migration free fouling release.</li> <li>• Steady fouling release effect</li> </ul>  <ol style="list-style-type: none"> <li>1. Protective layer</li> <li>2. Siliconized film / non adhesive-composite film</li> <li>3. Tied coat (adhesion enhancer)</li> <li>4. Adhesive: Strong acrylic adhesive, seawater resistant</li> <li>5. Liner / backing: White kraft paper, 135g/qm</li> </ol>
<p><b>How does the removal of the coating systems from the ship's hull work?</b></p>	<p>There are principally three methods for the removal of anti-fouling systems:</p> <ul style="list-style-type: none"> <li>• scraping: sanding, grinding, or scraping by hand or equipment to scrape off the paint;</li> <li>• blasting: grit blasting (dry blasting, wet blasting);</li> <li>• water blasting/washing (low, medium and high pressure).</li> </ul> <p>As with facilities for coating removal, basic requirements for the facility are a watertight floor or work surface and a means for capturing and containing AFS waste, fouling materials, dust, and, if water is used for removal, water contaminated with waste. Disposal of hazardous waste necessary.</p>	<ul style="list-style-type: none"> <li>• The film coating system is removed by water jetting.</li> <li>• No disposal of hazardous waste from paint and biofouling.</li> </ul>

<p><b>What safety needs have to be considered during application of the coating systems?</b></p>	<ul style="list-style-type: none"> <li>• Personal precautions, protective equipment and emergency procedures necessary</li> <li>• Substance classified with a health or environmental hazard (DANGER)</li> <li>• Wear protective gloves, protective clothing/eye protection/face protection</li> <li>• Keep away from heat, hot surfaces, sparks, open flames and other ignition sources</li> <li>• Flammable liquid and vapor</li> <li>• Very toxic to aquatic life with long lasting effects</li> <li>• Sufficient ventilation is very important to ensure proper drying</li> <li>• Extensive scaffolding required</li> </ul>	<ul style="list-style-type: none"> <li>• No personal precautions, protective equipment and emergency procedures necessary</li> <li>• No toxic environmental impacts</li> <li>• Simple handling</li> <li>• No drying time</li> <li>• Normal ventilation</li> <li>• No repainting</li> <li>• No vapor</li> <li>• No VOC</li> <li>• No extensive scaffolding required</li> </ul>										
<p><b>What are the drying times of the coating systems?</b></p>	<p>Organotin-free self-polishing antifouling paint,e.g.:</p> <table border="1" data-bbox="465 922 1077 1042"> <tr> <td>Substrate temperature</td> <td>5 °C</td> <td>10 °C</td> <td>23 °C</td> <td>40 °C</td> </tr> <tr> <td>Dried/cured for immersion</td> <td>12 h</td> <td>10 h</td> <td>8 h</td> <td>6 h</td> </tr> </table>	Substrate temperature	5 °C	10 °C	23 °C	40 °C	Dried/cured for immersion	12 h	10 h	8 h	6 h	<p>Biocide-free fouling release coating film:</p> <p>No drying time. Ready for use after application of film coating system. Primer needs drying time.</p>
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<p><b>How is the wet film thickness (WFT) measured?</b></p>	<p>To ensure correct film thickness, it is recommended to measure the wet film thickness continuously during application using a painter's wet film comb (ISO 2808 Method 1A). Total dry film thickness (DFT) of underwater hull and boot top systems ranges from 250-400 µm.</p>	<p>Uniform surface and constant thickness. No measurement necessary. Weight: 470 g/ m<sup>2</sup> (Foil + Primer) Thickness: 450 µm (Foil + Primer)</p>										



<p><b>What are the application standards?</b></p>	<p>Remove possible oil and grease etc. from surface with suitable cleaner, followed by high pressure fresh water cleaning for a thorough removal of any possible weak structure of leached antifouling. Allow the surface to dry before coating.</p> <ol style="list-style-type: none"> <li>1. 1 – 2 x Primers (Anti-corrosion)</li> <li>2. Anti-fouling paint (airless spray)</li> </ol>	<ul style="list-style-type: none"> <li>• The surface must be free of anti-fouling paint.</li> <li>• The surface must be clean, dry and degreased with Isopropanol (or MACcleaner).</li> <li>• Apply 2 x special metal primer + 2 x MacEpoxy</li> <li>• MacGlide full release film o be applied dry and without bubbles or fold apply horizontal and without overlaps.</li> <li>• At a temperature of 20°C wait 24 hours or if the temperature is 10 °C wait 48 hours before the structure is launched.</li> <li>• Remove the MacGlide protective film preferably at an angle of 90°.</li> <li>• Seal the edges with MacGlide ZM Primer &amp; Repair and MacGlide TM Topcoat.</li> </ul>
<p><b>How are damages exposing bare substrate handled?</b></p>	<p>Remove all rust, loose paint, grease or other contaminants by spot abrasive blasting, mechanical grinding, water and/or solvent washing. Feather edges and roughen the overlap zone of surrounding intact coating. Apply the coating system specified for repair.</p>	<p>The affected area is cut out and covered with a new piece of foil, overlapping the damaged area ("patched").</p>
<p><b>Roughness</b></p>	<p>Using anti-fouling paint will result in increasing physical roughness over the time. Any increase in underwater hull roughness will increase ship resistance or vessel drag, resulting in an additional power requirement with increased fuel consumption and cost to maintain vessel speed.</p>	<p>The film coating system has a better flow resistance as anti-fouling paint. The film coating system always maintains the same roughness and low resistance due to its quality and surface texture. There will be no change of roughness with film coating systems.</p>

<p><b>What must be considered when using anti-fouling paint on aluminium?</b></p>	<p>Anti-fouling paint can cause galvanic corrosion (bimetallic corrosion) due to its chemical composition. Aluminum can corrode preferentially when it is in electrical contact with another, in the presence of an electrolyte, e.g. copper that is part of the anti-fouling paint mixture.</p>	<p>The biocide-free fouling release coating film does not cause any galvanic corrosion. In practice, the aluminium hull is washed and the film coating application is done directly on the aluminium hull.</p>
<p><b>Durability</b></p>	<p>Antifouling life is a function of the biocide package, the biocide reservoir within the paint, and the rate of release.</p> <p>The durability of the coating depends upon its resistance to mechanical damage, the erosive effects of water movement, and the softening or solution of the components of the paint. Since the paint must disintegrate slowly to permit the liberation of the toxic, a compromise must be found between toxicity and durability.</p> <p>Biocide release rates decrease exponentially with time and effective life is limited: Up to 36 months on vertical sides and up to 60 months on flat bottom.</p>	<p>The manufacturer of the biocide-free fouling release coating film provides a minimum guarantee of 60 months.</p> 

**How do anti-fouling systems work on fixed steel structures like rigs, Jack-ups and platforms?**

Mobile infrastructure, such as drilling rigs etc., represent a special vessel sector which spends long periods idle or with low activity.

Antifouling paints contain a biocide, or toxin, held within the structure of the paint. The coating is designed to leach biocide slowly into the marine environment when seawater reacts with the surface layer of the paint.

For maximum effectiveness of a self-polishing antifouling paint the speed and activity of the vessel is essential.

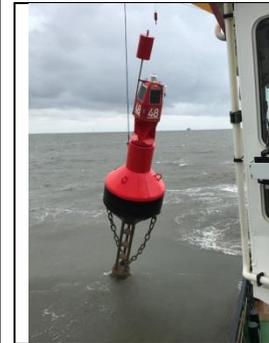


Buoy 45:  
Standard protection paint



Buoy 45:

The biofouling on a biocide-free fouling release coating film is already washed off by tidal currents.



Buoy 48:  
Fouling release film coating system



Buoy 48:  
Out of water:

Samples:  
Offshore Foundations



Colonization by mussels on protective structures of the Horn Rev offshore wind farm in Denmark.

Samples:  
Bio-Fouling Transition Piece  
Anchor chain

