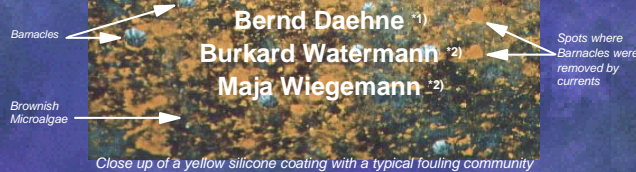


Long-term performance of silicones on coastal operating ships



Lower Saxonian Board for Ecology
Coastal Research Station ⁽¹⁾
Norderney, Germany
hanslik.crs@t-online.de



Close up of a yellow silicone coating with a typical fouling community

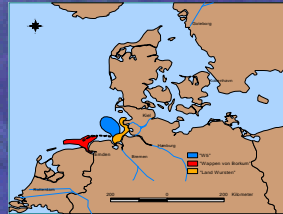


Laboratory for Freshwater/Marine Research
and Comparative Pathology (LimnoMar) ⁽²⁾
Hamburg, Germany
mail@limnomar.de

Introduction

In a current project 34 different non-toxic antifouling paints have been applied on 8 deep-sea going vessels and 11 coastal operating ships in dockyard practice, including pretreatment and state of the art application techniques. The performance of the test coatings is assessed at drydockings or at low tide on sandy beaches by fouling coverage, dry weight of fouling and adhesion of barnacles.

Most ships have been painted in 2000. The long-term performance of these non-toxic antifouling paints will be evaluated in 2002 and 2003.



But three of the coastal operating vessels had been coated in a previous research project in spring 1998: The patrol boat "W5", the passenger ferry "Wappen von Borkum" and the beam trawler "Land Wursten". Trading waters of the three ships are depicted in the figure on the left. They serve for investigations on the long-term performance of non-toxic antifouling paints, especially silicones. Each year the inspections took place in september and october at the end of the fouling season. In this way the yearly maximum of fouling development is examined. All tested products are encoded.

Results

Fouling coverage

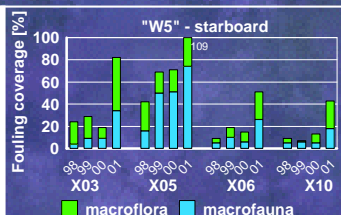
Dry weight of fouling

Adhesion force

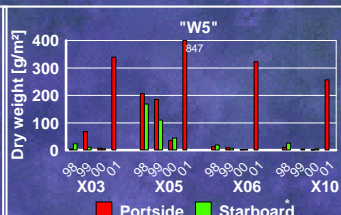


The "W5" is a 35 m patrol boat of the Lower Saxonian Coast Guard. The ship has a low activity level (20%) but it can speed up to 15-19 knots. Port of registration is Wilhelmshaven.

Different types of biocide-free antifouling paints had been applied in 1998. As seen in the figure above the left part of each test patch had been cleaned by low water pressure (5 bar) and sponge in autumn 1999. Only the silicone test patches could sufficiently be cleaned.



On three out of four silicones the macroflora coverage varied between 10 and 25% for 3 years under investigation (X03, X06, X10). In 2001, 39 months after application, the fouling degree increased up to 40% and even more. This level was measured on the fourth silicone X05 in the first year. In the following years the fouling coverage on X05 exceeded 60%.



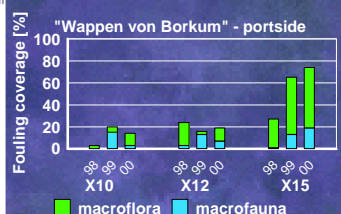
Dry weight of fouling corresponded positively to the fouling coverage. Dry weight values of X03, X06 and X10 were rather low compared to X05. The low fouling weight on all test patches in 2000 was caused by 1 month berthing in freshwater. Most marine organisms died and left just remnants behind. 39 months after application the fouling weight on all silicones had increased.



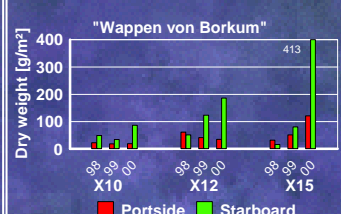
The adhesion force was plotted for the barnacle genera *Balanus* and *Elminius* separately. In general *Balanus* adhered stronger than *Elminius*. High values in 1999 were maybe caused by a low temperature which might have influenced the adhesive properties or simply the process of data collection. While X05 showed a significant increase in 2001, which corresponds positively to the results of fouling coverage and dry weight, the other silicones showed still low adhesion values 39 months after application, whereas X06 is the only one without extruding liquids.



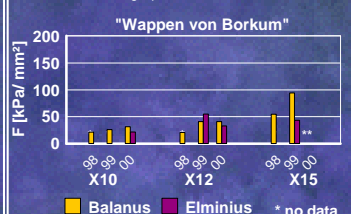
The "Wappen von Borkum" is a 43 m passenger ferry of the shipping company AG Ems. On this ship three silicones had been applied in 1998 and removed in 2000. The ferry boat is operating in different water salinities between Emden (1.5-2.3‰) and Borkum (2.7-2.9‰), sometimes the ferry is heading to the other East Frisian Islands. The ship has a medium activity level and the maximum speed is 12 knots.



The two silicones X10 and X12 showed steady results for three years. The measured values varied around 20% fouling coverage. X15 showed a similar performance in the first year only. In the following years, the fouling coverage increased and reached values above 70% in 2000.



Regarding the dry weight of the fouling community similar results were investigated on portside. On starboard significant higher values were obtained than on portside. Starboard is exposed to the light at harbour. For this reason more algae had grown and caused an increase of the fouling weight on all test patches.

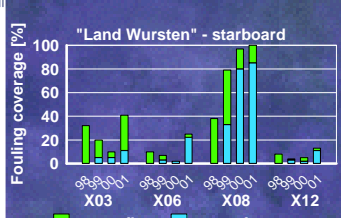


On the surfaces of all test products of "Wappen von Borkum" just low adhesion values of *Balanus* and *Elminius* were recorded. On X15 an increase was recognized in 1999. X10 and X12 showed more or less the same values over a period of three years. All three products are extruding liquids to improve the performance.



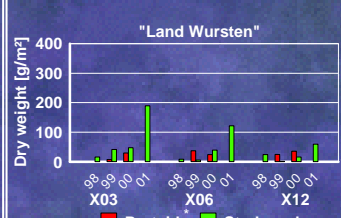
The 24 m beam trawler "Land Wursten" was offered by the owner for testings of biocide-free antifouling paints since 1998. The ship spends most of the time in brackish water at the "Wurster Küste" (2.1-2.7‰) and falls regularly dry at low tide. Maximum speed of "Land Wursten" is 12 knots.

In addition to three silicones (X03, X06, X12) one biocide-free SPC (X08) has been applied. The fouling coverage for this SPC is given for comparison purposes.

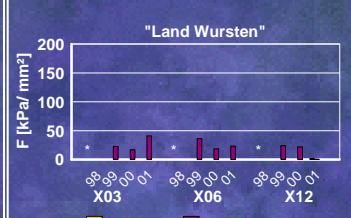


On the "Land Wursten" the silicones X03, X06 and X12 showed low coverage of macrofouling. Three years after application the fouling coverage was below 10%, in the fourth year it increased slightly.

In contrast to the well performing silicones the self-polishing coating X08 was clearly depleted in the second year after its application. In the first year the fouling coverage was similar to that of the silicones, in the second year the fouling coverage exceeded 80%. X08 was obviously polished off.



The results of the dry weight correspond to the results of the fouling coverage. For three years on both sides of the ship low values were measured, in the fourth year an increase was recorded especially on X03. But X06 and X12 performed well 39 months after application.



The adhesion force was investigated on "Land Wursten" first in 1999 when the silicones were on the hull for 17 months. From 1999 to 2001 *Elminius* adhered weakly on all silicones. *Balanus* was missing in 1999 and 2000. In 2001 a few individuals of *Balanus* had settled on X12 but they achieved just very low adhesion values. Again X06 without extruding liquids attained similar results as X03 and X12 with extruding liquids.

Conclusions

- Four out of six silicones achieved a good performance up to three years reflected in fouling coverage, dry weight of fouling and adhesion force of barnacles.
- On a ship with low fouling pressure ("Land Wursten") the performance was still satisfactory after 39 months.
- On coastal operating ships the fouling development between both sides may differ, caused by the influence of light (quayside - seaside).
- Only two of the silicones under investigation contained no extruding liquids (X05, X06). One of them (X06) showed the best results including all parameters.

- Barnacles of the genera *Balanus* were able to adhere much stronger than *Elminius*. *Elminius* never achieved adhesions above 100 kPa/mm².
- Except X15 there was no significant increase of barnacle adhesion on all silicones over a period of three years.

These projects are funded by:

Deutsche Bundesstiftung Umwelt (DBU), Osnabrück
Environmental Ministry of Lower Saxonia, Hannover
WWF Germany, Marine and Coastal Division, Bremen,
Niedersächsische Wattenmeeresstiftung, Hannover
Niedersächsische Lotostiftung, Hannover

For more detailed informations about the projects on antifouling of LimnoMar (Hamburg) and Coastal Research Station (Norderney) please visit our websites: www.limnomar.de & www.nioe.de or order our first interim reports:
WATERMANN, B., B. DAEHNE, H. MICHAELIS, S. SIEVERS, R. DANNENBERG & M. WIEGEMANN (2001): Performance of biocide-free antifouling vessels - Trials on deep-sea going vessels. Vol. 1: Application of test paints and inspections 2000. Edited by the WWF Germany, Marine and Coastal Division, Bremen, Phone +49-421-65846-10, Fax -12