Polyhexamethylene guanidine as an effective biofouling inhibitor in marine paint

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One of the major elements which define the longevity and the performance of a ship, is the quality of the coating. Coatings help to protect against corrosion (e.g. of the hull or of the ballast tanks) as well as against the formation of biofouling layers (mostly on the outer hull). Low levels of biofouling ensure a low fuel consumption, whereas low levels of corrosion mean less profitless days in dry-dock for maintenance and inspection. Recent results on antibiofilm activity of cationic polymeric biocide polyhexamethylene guanidinine (PHMG) salts as an additive in polyamide plastics for medical use (Walczak et al 2014, Moshynets et al, accepted) hinted at a possible interaction between this molecule and the bacteria attempting to colonise an exposed surface. The presence of the compound effectively slowed down the formation of a functional biofilm. It was therefore hypothesised that this compound may be exhibiting a certain level of efficacity when introduced in paints, eg for ships' hulls. With lab testing on the exact mechanism still ongoing, a practical test was set up as well.

In this study, hydrophobic polymeric biocide PHMG 2-mercaptobenzothiazolate (PHMG-MBT) has been synthesized. Moreover, PHMG was intercalated into a smectic clay, montmorillonite (MMT) to develop hybrid organic/inorganic biocide (PHMG-MMT). To study the antifouling performance of PHMG based additives in a maritime setting they were mixed into a classic ship's hull epoxy based paint in the content of 5 wt%. The coupons were exposed to seawater at our pilot station in the Ostend port for three months. Afterwards, the coupons were carefully dried, pictures were taken and the abundance of the fouling was assessed by measuring the percentage of the coupon surface that was covered (with algae and slime, mostly), using the image processing software ImageJ.

ANOVA testing (for treatment type and the position of the coupon on the rack) showed that the treatment of the coupons was shown to be highly significant in the determination of the fouling ($p<0.001$). Subsequent t-tests indicated that only one of the two treatments, the PHMG-MMT, affected the development of the fouling layer ($p<0.001$). The position of the coupon had a significant effect as well ($p<0.05$) even though the difference between top and bottom coupons was only 30 cm.

In short, cationic polymeric biocide, PHMG may be useful as an additive in commercial paint formulations, to enhance the paint's anticorrosion and antifouling behavior. As its behavior in polyamide plastics did not depend on leaching out the surrounding medium, one of the parameters to be tested will be whether this is also the case for epoxy paints. In that case, the use of such a formulation may well provide for a more durable way of coating ships.

References

- Moshynets, O., Bardeau, J.F., Tarasyuk, O., Makhno, S., Cherniavska., T, Dzhuzha, O., Potters, G., & Rogalsky, S., Antibiofilm activity of polyamide 11 modified with thermally stable polymeric biocide polyhexamethylene guanidine 2-naphtalenesulfonate. I*nternational Journal of Molecular Sciences*, accepted for publication
- Walczak, M., Richert, A., & Burkowska-But, A. (2014). The effect of polyhexamethylene guanidine hydrochloride (PHMG) derivatives introduced into polylactide (PLA) on the activity of bacterial enzymes. *Journal of industrial microbiology & biotechnology*, *41*(11), 1719-1724.

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