Study of Biocide Release from Antifouling Paints — Verification of Mass Balance Calculation Method by Actual Measurement —

Mizuho Honma *,†; Hiroyuki Teragaki *, Hiroyuki Takaki * and Yasuyuki Kiseki *

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Abstract

Mass balance calculation method, which is one of the evaluation methods to estimate the release rate of biocides into the sea from antifouling paints, is theoretical method but not the actual measuring one. This paper reports an actual measuring result in comparison with the theory of the mass balance calculation method. The procedure to achieve this purpose, consumed film thickness and consumed copper amount from test panels were measured to get the total amount of copper released, then divided by immersion periods to get the release rates of copper.

The result of hydrolysis type antifouling paint showed constant copper release during the test periods. On the other hand, the result of ablative type antifouling paint showed larger copper release at the first two months then became smaller at the later periods. But when the lifetime of antifouling paints was considered, the results were close to the values of mass balance calculation method. From the results, both types of antifouling paint were considered to be applicable to mass balance calculation method.

Key-words: Antifouling paint, Release rate, Copper, Mass balance calculation method

1. Introduction

Existing standard test methods of measuring release rate of biocides from antifouling paint for use in laboratories are ISO15181-1-51, ASTM D 6442-06 and ASTM D 6903-07. These methods are used to determine the amount of biocide leached out of an antifouling paint surface by controlled immersion for 45 days in artificial seawater. There are however some indications that the results of these methods are much higher than the amounts of biocides released from actual ship’s bottoms and the results are overestimated for environmental risk assessment.

On the other hand, a mass balance calculation method is soon to be approved as International Standard. This method is used to calculate the release rate of biocides from antifouling paint on the basis of the paint formulation and the specified film thickness rather than measuring it. In theory, a correct value for the release rate can be obtained by this method but there is no evidence at present. Additionally, no third party can check the results unless they have access to paint formula and specification.

Our study here is an actual measuring according to the theory of mass balance calculation method. Consumed film thickness and consumed biocide over the immersion periods are measured to accomplish this work. Within this new approach, we determined two typical kinds of antifouling paints which have different leaching mechanism and compared between the measured and estimated values of mass balance calculation.

2. Theory

The procedure of the biocide release rate of ISO/FDIS10890, mass balance calculation method is calculated using the following equation:

\[
\dot{m}_{rel} = \frac{(L_a \times a \times w_a \times \rho \times DFT)}{\varphi} \quad (1)
\]

\[
\bar{R} = \frac{m_{tot}}{(365 \times i) / 12} = 0.0329 \times \frac{m_{tot}}{t} \quad (2)
\]

where:

- \( \dot{m}_{rel} \) is the estimated total mass of biocide released per unit area of paint film over the lifetime of the paint, in \( \mu g \ cm^{-2} \);
- \( L_a \) is the percentage of biocide that is released from the paint film during the lifetime of the paint;
- \( a \) is the mass fraction of biocide in biocidal ingredient;
- \( w_a \) is the content of biocidal ingredient in the paint.