MARINE COATINGS

The Royal Institution of Naval Architects

Conference Programme

International Conference on Marine Coatings

THURSDAY 18TH APRIL, RINA HQ, LONDON, UK

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PAPERS:

08.30-09.00 COFFEE & REGISTRATION

A NOTE ON CURRENT ANTI-FOULING ISSUES
Dr RL Townsin
The introduction of organo – metallic biocides into anti-fouling coatings, and, in particular, ablative tri-butyl tin coatings (SPC TBT), led to the expectation that fouling was 'yesterday's problem'. Paint roughness then became the predominant cause of surface resistance penalties. The total banning of TBT has led to the use of less virulent biocides, or, non-biocidal, low surface energy, foul release coatings and, even, hard coatings for underwater brush cleaning. These current panaceas for hull fouling seem variously less effective as anti-fouling measures than SPC TBT.

In addition to the economic penalties arising from a fouled hull, environmental smokestack issues are of growing concern. Some ports and harbour authorities are becoming concerned about sedimentary problems and invasive species, which latter, are thought to arise from inadequate fouling prevention, in addition to the notorious invasion from ballast water discharge.

All these circumstances have led to marine coatings manufacturers, and their ship-owning customers, to pay increasing attention to the effectiveness of the various anti-fouling products on offer. The high cost of recoating and any subsequent economic fouling penalties, have led some paint companies to attempt to devise guarantees of effectiveness of their products, based upon some measures of speed/power performance of a ship from out-docking after anti-fouling coating. Such in-service data collection and analysis is notoriously difficult.

AN OVERVIEW OF MARINE CORROSION PROTECTION WITH REGARDS TO CATHODIC PROTECTION AND COATINGS
Tahsin Tezdogan, Yigit Kemal Demirel, University of Strathclyde, UK
Corrosion is the gradual deterioration of a material or its properties through a chemical reaction with its environment. Corrosion, which is frequently seen on ship surfaces, can occur locally on a material surface to form a pit or crack, or it can cover a wide area more or less uniformly. It causes some direct and indirect costs for repair, and if it is not eliminated, it may lead to fatal accidents. However, it is possible to avoid corrosion or minimise its rate.

Corrosion can be eliminated only if one of the corrosion reactions is eliminated. For ships, there are several ways of preventing the material from the corrosion, but they ought to be planned properly. Cathodic protection (CP) and coatings are very popular methods for corrosion protection. Every single method has its own pros and cons whereas experience has shown that the most effective way of corrosion prevention method is a combination of CP and coatings. This method can provide very good protection over a long period of time.

This paper outlines cathodic protection methods, and mainly focuses on the combination of CP and coatings for marine vessels. Firstly, corrosion prevention methods are briefly summarized and the effect of installation CP as back up for the coating is illustrated. Afterwards, calculation of a CP design is explained briefly and the factors affecting the choice of the type of CP system are demonstrated clearly. Then, a sample anode plan of a ship is shown. Finally, as a real case study, the calculation of a cathodic protection system of a ship is presented in detail in the paper owing to the data provided by coating manufacturers and shipyards.

THICKNESS OF MARINE COATINGS: MEASUREMENT, STANDARDS AND PROBLEMS
Rob Francis, R A Francis Consulting Services, AUSTRALIA
Dry film thickness (DFT) is probably the single most important measurement made during inspection or quality control of protective coating application. Even the most basic protective coating specification will inevitably require the DFT to be measured. The introduction of IMO resolution MSC 215(88) on Performance Standards for Protective Coatings has drawn attention to the importance DFT measurement in achieving the desired durability of protective coatings in marine applications. This document, along with DFT standards from ISO in Europe and SSPC in the USA, provide the coating specifier, applicator and inspector with information on measuring techniques, acceptability of readings, inspection plans and other important aspects of DFT measurement. This presentation describes DFT measurement and compares the requirements of the IMO performance Standard with those described in other Standards. Issues such a method of gauge calibration and adjustment, number of readings and deciding if readings are acceptable or not can vary according to the standard used. This paper will provide examples of typical readings and how they can be analysed. It will suggest some important areas that must be examined to remediate inconsistencies and inefficiencies in DFT specification, measurement and analysis of results.

A PARAMETRIC STUDY: HULL ROUGHNESS EFFECT ON SHIP FRICTIONAL RESISTANCE
Yigit Kemal Demirel, Osman Turan, Atilla Incecik , University of Strathclyde, UK
Ship resistance is very important in terms of ship performance and fuel consumption. The more resistance a ship has, the more fuel it consumes for the same range.

Ship resistance can be broken into two parts; frictional resistance and residuary resistance. Especially for merchant ships which sail with normal or low velocity, frictional resistance may be 60-90% of the total resistance and it is directly affected by surface roughness; namely physical and biological roughness. Hull roughness leads to frictional resistance increase which means fuel penalty. Marine coatings are widely used in order to avoid or minimise fouling and hull roughness, hence increase in frictional resistance.

This paper outlines details of a parametric numerical study which was carried out to monitor the effect of changing surface roughness of marine coatings on ship frictional resistance. This investigation was made by means of a computational fluid dynamics (CFD) based software (STAR-CCM+).

Firstly, towing test simulations of a flat plate were conducted and the results were compared with the experimental results given in literature to validate the model. After the validation procedure, a parametric study was carried out to obtain frictional resistance and frictional drag coefficient variations depending on various hull roughness conditions. Moreover, a simple formulation which correlates the roughness height and frictional drag coefficient was obtained within the validated roughness height range and speed. Finally, the results were presented in both graphical and tabular forms and discussed in details.

A STUDY FOR THE EFFECT OF SURFACE ROUGHNESS ON RESISTANCE CHARACTERISTICS OF FLAT PLATES
Onur Usta, Emin Korkut, Istanbul Technical University Faculty of Naval Architecture and Ocean Engineering Istanbul, TURKEY
Viscous resistance of a ship (friction resistance + viscous pressure resistance) increases as hull surface roughens. In this study, resistance experiments of five aluminium plates were carried out to determine effect of surface roughness on friction resistance. Plates had the same geometrical particulars but different surface roughness characteristics. Four of the plates were coated with different antifouling coatings and one of the plates was left uncoated as the reference plate. Resistance experiments were carried out in the towing tank of Ata Nutku Ship Model Testing Laboratory for a range of towing speed 0.5 m/s to 3.75 m/s. Total resistance of the plates for corresponding speeds were measured. Resistance components of the different coated plates were calculated and compared. In addition to this, a computational domain was created and Computational Fluid Dynamics (CFD) analyses were carried out for 5 different plates by generating the same conditions as the resistance experiments. Analyses were performed by using a commercial CFD code, which is based on Finite Volume Method. According to both experimental and CFD results, surface roughness plays an important role in resistance characteristics of the plates.

PAPERS:

EVALUATION OF ELECTRODEPOSITED POLYANILINE ON MARINE GRADE ALUMINIUM FOR ANTIFOULING PROPERTIES

T To, University of Auckland, AUSTRALIA

Antifouling coatings are generally defined as those that can prevent the settling of microorganisms on a surface through the controlled release of toxic agents. There is considerable interest in the development of coatings that are non-toxic to the environment, but also prevent unwanted microbial-based fouling. Many conducting polymers have been studied for different applications, with polyaniline the first to show antifouling properties1. The objective of the research is develop an optimum polyaniline coating on aluminium alloys that does not release toxic chemicals, but at the same time provides a useful antifouling property.

Polyaniline films were synthesized electrochemically from 0.5 M oxalic acid solution containing 0.1 M aniline, under potentiostatic control. Coated and control marine grade aluminium were challenged by immersion in growing cultures of Escherichia coli ATCC 25922 lux and E. coli 536 lux under controlled conditions to simulate the marine environment in an accelerated fashion. This novel testing method allowed a non-destructive evaluation of bacterial growth on different surfaces, using selected coatings, with bioluminescence from bacteria colonizing the aluminium coupons imaged using an IVIS kinetic at 24 hourly intervals over a 2 weeks period (Figure 1). Only live bacteria bioluminesce and so signal (seen as a pseudocolour image in figure 1) reflects areas of the coupon colonized by bacteria. Polyaniline-coating of marine grade aluminium delays colonization indicating a lower rate of fouling.

THE SMOKE DENSITY EVALUATION AND DYNAMICS INVESTIGATION OF ACRYLIC AND INTUMESCENT

Zhishi Li, Huajin Wang, Wei Zhao, Jun Zhao, Wei Lu, Marine Chemical Research Institute, 4 Jinhu Road, CHINA

Herein, the capability influence of acrylic to intumescent is discussed. Meanwhile, the thermal decomposition kinetics of both acrylic and intumescent are investigated. Initially, the static smoke density of both acrylic and intumescent is measured. Results show that acrylic has a quite higher smoke density comparing to intumescent during burning process. The thermogravimetric (TG) and derivative thermogravimetric (DTG) curves of both acrylic and intumescent are obtained. Combining with the smoke density data, the smoke contribution of acrylic during the intumescent burning process could be estimated. Approximately, acrylic is decomposed 21.13% for whole, that's the 6.67% of intumescent. These results can be deduced that acrylic contributes 34.64% in smoke density during the intumescent burning process. Furthermore, Freeman—Carrol method and Coats—Redfern method are chosen for kinetics investigation. The active energy and reaction order are calculated for both acrylic and intumescent. The initial decomposition temperature of acrylic is higher than intumescent, and calculation results show that acrylic has higher active energy than intumescent. That identify with the smoke density data, which the acrylic initially smoking time is shorter than intumescent. The reason may indicate that the additives in intumescent decompose earlier than acrylic. Although have lower active energy, intumescent remains 49.34% in weight. All these consequence own to the exit of fire retardant system restrain the flame spread.

THE BETTER ALTERNATIVE UNDERWATER HULL COATING SYSTEM IS ALREADY HERE

Boud Van Rompay, Founder and CEO, Hydrex.

The best of all worlds in underwater hull coating systems is a non-toxic, hard, surface treated composite (STC) which lasts the life of the hull without need for replacement or major repair, which gets smoother with time and in-water cleaning rather than degrading. STCs are easy to apply, are very tough even in ultra-harsh environments such as ice and gravel, can be cleaned of any level of fouling without any damage to the coating or harm to the environment and have even been proved to protect rudders from cavitation damage. They meet all current and predicted regulatory requirements. They offer the full, non-toxic answer to the NIS issue. Used standardly in conjunction with in-water cleaning, they are capable of the highest level of fuel efficiency over the entire life of the hull. This paper will present STCs as the better alternative underwater hull coating system, available now and of immediate interest to naval architects, shipbuilders, ship-owners/operators and regulatory/environmental organizations.

NEW HORIZONS IN MARINE ANTIFOULING COATINGS

Yigit Kemal Demirel, Osman Turan, Atilla Incecik , University of Strathclyde, UK

Marine biofouling of mobile and stationary maritime structures is a significant problem from not only economical but also an environmental point of view. It leads to increased fuel consumption and hence increased greenhouse gas emissions as well as to transportation of harmful non-indigenous species.

Antifouling coatings are widely used to avoid or to minimise fouling as the most effective way. The antifouling coatings containing tributyltin (TBT), which is a toxic biocide, were highly preferred for decades since they have low initial roughness and perfect antifouling properties, besides they do not need maintenance for a long time. Nevertheless, the research demonstrated that TBT has a lot of negative effects on marine environment. As a consequence, IMO banned the applications of antifouling coatings containing TBT in 2003 and the operations of ships if they were coated with TBT containing paints in 2008. Therefore, the research on alternative antifouling coating systems that are not harmful to environment has been accelerated.

This paper aims at introducing new horizons and novel approaches in marine antifouling coatings such as bio-inspired coatings. Firstly, marine biofouling and fouling prevention methods are introduced briefly. Afterwards, some recent novel and environmentally friendly antifouling approaches and the latest research are presented. Then, several biomimetic approaches and bio-inspired antifouling strategies, namely chemical, physical and stimuli-responsive strategies, are presented as well as the challenges in designing bio-inspired antifouling coatings are discussed in detail.

It is believed that, the current research on antifouling coatings will lead to very effective prevention of marine biofouling while maintaining the harmony between man-made structures and marine life.

17.00- GENERAL DISCUSSION & DRINKS RECEPTION

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Following the end of day one, delegates are invited to attend an evening drinks reception at the conference venue.

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Upon registration you will be provided with details of a hotel booking service offering reduced rate accommodation for conference participants.

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