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AN ASSESSMENT OF ABLATIVE ORGANOTIN ANTIFOULING (AF) COATINGS

There are ever-increasing demands in the marine industry for antifouling paints that will extend drydocking intervals and improve resistance to marine fouling. The accumulation of fouling reduces a ship's speed and increases fuel consumption in order to overcome the resulting drag.

BACKGROUND

The primary toxicants over the last 100 years have been copper salts added to vinyl and other paint resins. These paints have been marketed by every major paint company for the marine industry and sold in retail stores and marinas for pleasure boats. The U.S. Government's own version of cuprous oxide in vinyl has been designated as formula 121 and 129 under specification MIL-P-15931. This paint has been used since 1952 on U.S. Navy, Coast Guard, and other ships owned by agencies of the U.S. Government.

The materials perform through the gradual leaching of the toxicant through the paint film and prevents the attachment of marine fouling. However, at the very best, these materials perform anywhere from 18-24 months; in tropical waters, we're lucky if we get 12 months service.

The causes of this short service life are attributed to the following reasons:

(1) Physical Properties - Since the toxicant is an additive, there is no way to control the leaching process. At the outset, the leach rate is high due to the concentration of the toxicant in a fresh coat of paint. In the early stages after undocking, we have more toxicant exuding than is needed to control fouling. This fact also contributes to the rapid depletion of the toxicant and the early demise of the coating's effectiveness.

(2) Chemical Properties - Cuprous oxide hydrolyzes in seawater and undergoes a chemical conversion to become a less toxic copper complex salt consisting of hydroxide, carbonate, and oxychloride. This complex salt forms a hard crust which inhibits the further leaching of active cuprous oxide ions from the layer under the crust. As the concentration of copper salts diminshes, we begin to see the attachment of marine fouling in the following order:

A. First we have the formation of slime. This begins to form in a few days after undocking.

B. Second we note the seaweed, which start to appear after 6 months to a year.

C. Third is the attachment of tube worms, barnacles, and other crustacea.

D. Fourth and last are the tunicates, the most sensitive of the fouling organisms, which in effect indicate the complete demise of the coating.

Once the hull fouls, the excess drag imposes a costly fuel penalty to maintain the ship's speed. When fuel was cheap, we accepted this as a way of life, and as the fouling accumulated, we turned up the fuel flow to overcome the drag. Now that fuel is costly, we cannot continue to overlook the problem.

In lieu of drydocking, we have an interim procedure of removing marine fouling with mechanical underwater brushes operated by divers.

This admittedly serves the immediate purpose to remove the fouling, restore ship's speed, and to reduce energy costs, but in so doing, there is a loss of film thickness and mechanical damage to the antifouling paint.

Once mechanical underwater cleaning is started, we're locked into it — it's like getting hooked on drugs — and the intervals between successive cleanings become progressively shorter due to the removal and damage of the antifouling coating.

Consequently, mechanical cleaning is only an interim method and a necessary evil until something better comes along.

We are definitely in need for a coating system with a longer service life than copper, and one which does not begin to accumulate fouling soon after the ship leaves the drydock.

Ideally too, is the need to supersede costly and damaging underwater brushing by having the inherent chemistry of the antifouling paint perform in an ablative fashion to continually provide a self-cleaning action to maintain a foul-free surface during the life cycle of the AF coating.

It appears that ship owners have finally found such a material in the commercially available ablative organotin coatings.

We in the Navy certainly want to get the longest possible service life from our antifouling paints. This is emphasized in a non-classified directive issued in September 1981 by the Chief of Naval Operations who imposed drydocking intervals of up to 10 years for some classes of ships. Our plan of action is to evaluate ablative organotins with their extended life cycle properties.

The ablative paint system was introduced in Europe in 1974. I had an opportunity to assess its performance on commercial ships in 1978 when I was still with the Coast Guard. I was convinced that the paint merited a Coast Guard service test and arranged for its application on a Coast Guard cutter in February 1979.

At the November 1980 drydocking the ship looked as good as the day it was painted. The companion barge with the control paint was heavily fouled.

The erosion rate is about 50 microns a year for this ship which operates at about 10 knots. Consequently, the projected service life for the 400 microns of antifouling paint is approximately 8 years. The ship's captain reports that the ship has had an average of 10 percent fuel savings since 1980.

At the June 1983 drydocking, the AF coating was found to be in excellent condition after 4 years, 4 months in tropical waters off Florida. As in November 1980, the hull was washed and the ship was returned to the water without painting except for touching up a few surfaces that had been mechanically damaged by grounding and rubbing against piers. The control coating on the barge was heavily encrusted with fouling, and was removed to base metal. This is the second time that the control coating had to be removed and replaced while the test coating continues to perform foul-free.

The first ablative coating in the Navy was applied in November 1980 on USS SPRUANCE using the same material that was used on the Coast Guard cutter. At the time, it was the first and only commercially available material.

At the October 1981 drydocking, the SPRUANCE AF coating was in excellent condition after 1 year. It's still foul-free today after 2 years, 9 months.

In June 1981, another Navy ship, USS SAMPSON was coated with an ablative coating from a second vendor.

At the March 1982 drydocking, the ship was foul-free and remains that way after more than 2 years.

Neither of these ships has been drydocked since these photos were taken and the foul-free condition of the hulls was reported by divers.

The two ships are operating respectively 33 and 26 months foul-free at a point in time when each of them would have required either underwater brushing or drydocking to remove marine fouling if the standard cuprous oxide coatings were used. The performance of these coatings will be monitored, together with newer materials now available in the commercial sector, in order to determine which coatings satisfy our requirements.

The Navy estimates that ablative organotin paints will reduce fuel costs by about 10 to 15 percent, or approximately $300 million a year.

The earlier ship, coated in November 1980, has reported that the $100,000 extra cost of materials and labor for the ablative coating was recouped from the fuel savings alone in the first 6 months of the second year of operation.

Continued fuel savings and elimination of underwater brushing will make this type of coating more cost effective for the Navy and other ship owners. Savings are realized in the second year and thereafter, because the copper paints do not foul sufficiently during the first year of operation to show a significant rise in fuel.

The overall performance of an ablative system depends on the erosion and leach rates which are affected by ship's speed, hull contour, temperature and variations in ocean salinity.

As more new coatings become available, we are finding it expedient to apply a half dozen patches on one ship representing various manufacturers who passd preliminary screening tests in the laboratory. This was done recently on the destroyer USS BARNEY in June 1983.

Another method of multiple testing is to outfit the bilge keel of a ship with studs on which panels can be attached and tested under identical operational conditions. This type of testing was done on the aircraft carrier KITTY HAWK in August 1982 and repeated on BARNEY in June 1983. Because of the short test period, we do not have anything to report as yet.

By using paints with the lowest leach rates of 0.2 to 0.4 micrograms/sq cm/day, the Navy is minimizing any possible adverse impact on the environment.

In closing, I can safely say that ablative organotin AF coatings are accomplishing what copper paints have failed to do, and we are hopeful that they can help us reduce our fuel costs through foul-free operations, eliminate costly and damaging underwater cleaning, and increase the intervals between drydockings.

ABSTRACT

ABLATIVE ANTIFOULING COATING SYSTEMS

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The widely used cuprous oxide antifouling paints are no longer able to meet the increasing demands of the Marine industry. These paints were developed almost a century ago, and perform for about 18 - 24 months. In tropical waters we are lucky if we can get 12 months of service. When fuel and labor costs were cheap, this was an acceptable fact of life. Now that fuel and drydocking costs have soared, the Marine industry is looking for antifouling paints that will permit extended drydocking intervals and to perform foul-free between dockings to keep fuel costs to a minimum and in addition, to eliminate the costly underwater mechanical brushing. The new ablative antifouling coatings enable ship owners to achieve these results with organotin toxicants.

The Marine industry, including the U.S. Navy and Coast Guard are beginning to obtain foul-free underwater hulls of up to four years, and the clean hulls have produced a ten percent fuel savings per ship per year. In addition, the inherent, self-cleaning action has completely eliminated the expense of underwater brushing and the ensuing damage suffered by the antifouling coating by the mechanical process.

The U.S. Navy is investigating these ablative coatings and comparing its findings with those obtained on ships in the commercial sector. The overall results show a very close correlation regarding fuel savings and foul-free performance over longer drydocking intervals.

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