DALHOUSIE UNIVERSITY
FACULTY OF ENGINEERING

Team #15
Abdelrahman Abdelaziz
Shannon Clemens
Renfei Ge
Ben Lengkeek

Copsys Industries Inc.

Department of Mechanical and Materials Engineering

Evaluation of Antifouling Properties in a Marine Corrosion Prevention System

Introduction

Copsys has developed a coating using *impressed current cathodic protection* (ICCP) to prevent corrosion in marine applications.

- The coating has been tested and shown to effectively prevent corrosion
- It is suspected that the Copsys system also resists marine fouling due to the applied current

The goal of the project is to design and conduct a test to determine if the Copsys coating does in fact have anti-fouling properties.

Stages of Fouling [1]

Primary Film Formation → Biofilm Formation → Diatom and Protozoan Colonization → Settlement of Invertebrate Larvae and Algal Spores

Ideal Conditions for Fouling

-Salinity of 3.5%	-Roughened surface
-No seasonal interruption to growth	-Dark Surface
-Temperatures between 21.1°C and 37.7°C	-Bottom of surface
	-Flowrate of 1 knot

[2,3]

Design Process

Determination of Key Design Requirements

1. A High instance of fouling (as defined by ASTM D3626)
1. Salinity: 2.0-3.5%
2. Water Temperature: 10-30 °C
3. 8 Hours of light per day
4. Water circulation
5. Water exchange
6. Isolation of different conditions
7. Apparatus footprint less than 2ft²
8. Controlled access to test site
9. Apparatus cost less than $500

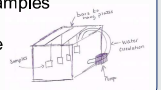
Natural Environment Test Site

A natural test site is ideal

- Unfortunately, water temperatures are too low for the majority of the project term
- This lead to the design of simulated testing in the lab

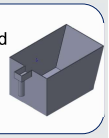
Initial Apparatus Design

- Large vessel housing all samples
- Pump to circulate water
- Samples hanging with rope
- Seawater exchanged manually by team



Dalhousie Aquatron

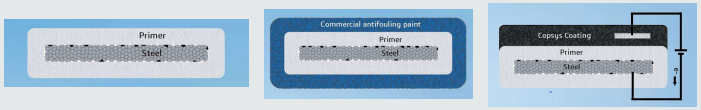
- It was determined that different coatings needed to be segregated during testing
- Aquatron have capabilities to supply a constant feed of heated seawater to individual tanks



[2], [4-7]

Application of the Copsys Corrosion Prevention System

Degrease Steel Plate → Solder Wire to Plate → Descaling (Sand Blast) → Apply Primer & Cure → Apply 1st Layer Copsys Coat → Attach Mesh Wire to Plate → Apply 2nd Layer Copsys Coat



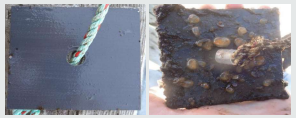
[8]

Natural Site Testing at The Bedford Institute of Oceanography (BIO)

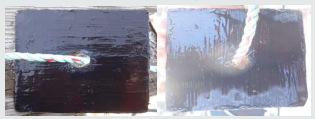
Six plates were hung on one rope and were suspended off a platform at the BIO facility

PVC, Commercial Coating, Copsys, Uncoated Steel

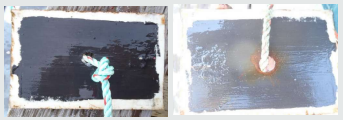
The images below show each plate in January (left) and March (right)



PVC (Control)



Commercial Antifouling Coating



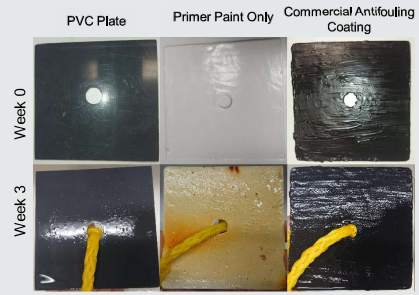
Copsys Coating

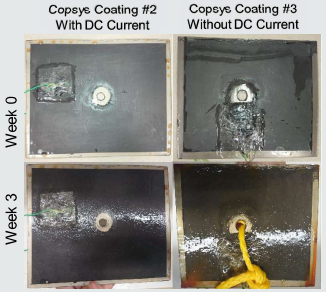
Significant fouling was observed on the PVC plate in March

The Copsys and commercial antifouling coating did not show any signs of fouling

Simulated Testing at The Dalhousie Aquatron

- Different sample conditions must be placed in different tanks so that they do not interfere with one another[6]
  - Copper containing coating can leach copper ions
  - Copsys coating is connected to an electrical current





Conclusions

- Water temperature is crucial in producing a high fouling environment
- The PVC control plate showed fouling at BIO following an increase in water temperature, validating the test procedure
- The Copsys coating did not show fouling, indicating that it does have fouling resistant properties

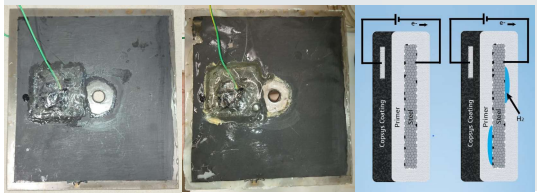
Recommendations

- Testing at the BIO facility should be continued in the summer when water temperatures are high
- Testing at Aquatron should continue for a longer period of time to obtain valid results

Improvements

- Standardizing sample size
- Improving the sealing procedure of plate edges
  - Hydrogen is a product of the chemical reaction required for cathodic protection[9]
  - Hydrogen atoms diffuse in between steel plate and primer causing delamination

Copsys Coating #1 With DC Current



References

1. Imo.org. (2018). *Biofouling*. [online] Available at: http://www.imo.org/en/OurWork/Environment/Biofouling/Pages/default.aspx [Accessed 29 Sep. 2018].
2. Marine Fouling and its Prevention (CH 1)-SC https://darchive.mblwhoilibrary.org/bitstream/handle/1912/191/chapter%201.pdf?sequence=8&isAllowed=y
3. Marine Fouling and its Prevention (CH 13)-SC https://darchive.mblwhoilibrary.org/bitstream/handle/1912/191/chapter%2013.pdf?sequence=22&isAllowed=y
4. ASTM International, "Standard Test Method for Testing Antifouling Panels in Shallow Submergence," 2012. [Online]. Available: https://compass.astm.org/EDIT/html_annot.cgi?D3623. [Accessed 2018].
5. J. Frail-Gauthier, Interviewee, *Professor in the Department of Biology at Dalhousie University*. [Interview]. 16 October 2018.
6. J. Batt, Interviewee, Aquatron Research Specialist . [Interview]. 4 December 2018.
7. C. DiBacco, Interviewee, Bedford Institute of Technology Test Set Up. [Interview]. 30 October 2018.
8. Copsys Corrosion Prevention, Copsys Coating Application Process, Halifax, 2019.
9. F. Hashemi, Interviewee, Imposed Current Cathodic Protection. [Interview]. 22 March 2019.