Evaluating the Efficacy and Environmental Impacts from Proactive In-Water Cleaning of Commercial Vessels

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Reactive Cleaning
Traditional paradigm of reactive in-water cleaning

Modified from: Scianni and Georgiades 2019
Newer Paradigm of Reactive In-Water Cleaning and Capture

Questions:
• How well do the systems clean?
• How well do the systems contain the removed debris at the point of cleaning?
• How well do the systems filter/treat the effluent before discharge?

Modified from: Scianni and Georgiades 2019
Proactive Cleaning
Questions:
• How well do the systems clean?
• Are biocides released? If so, at what concentration?

Modified from: Scianni and Georgiades 2019
Environmental risks associated with in-water cleaning

Reactive IWCC:
• Cleaning effectiveness
• Debris capture efficiency
• Filtration/treatment/removal efficiency

Proactive IWC:
• Cleaning effectiveness
• Biocide release?

Modified from: Scianni and Georgiades 2019
Project Team

https://www.act-us.info/

https://www.maritime-enviro.org/index.php
Environmental risks associated with reactive in-water cleaning with capture

Reactive IWCC:
- Cleaning effectiveness
- Debris capture efficiency
- Filtration/treatment/removal efficiency

Modified from: Scianni and Georgiades 2019
Environmental risks associated with reactive in-water cleaning with capture

Vessel 1:
• Baltimore, MD
• Heavy biofouling: 60-100%
• Low visibility: < 1m

Vessel 2:
• Alameda, CA
• Moderate biofouling: 50-75%
• Low visibility: < 1m
Evaluation of efficacy and environmental impact from reactive in-water cleaning with capture

Reactive IWCC:
• Cleaning effectiveness

<table>
<thead>
<tr>
<th>Surface Type</th>
<th>Number of Plots</th>
<th>Number of Images Within One Plot</th>
<th>Total Photos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical flat</td>
<td>6</td>
<td>16</td>
<td>96</td>
</tr>
<tr>
<td>Horizontal flat</td>
<td>6</td>
<td>16</td>
<td>96</td>
</tr>
<tr>
<td>Vertical curved</td>
<td>6</td>
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</tr>
<tr>
<td>Angled Surfaces</td>
<td>6</td>
<td>5</td>
<td>30</td>
</tr>
</tbody>
</table>

Evaluation of efficacy and environmental impact from reactive in-water cleaning with capture

Reactive IWCC:

- Debris capture efficiency
- Filtration/treatment/removal efficiency

Water Quality Parameters:

- Biocides (Cu, Zn)
- TSS, POC, DOC
- Particle size distribution

Modified from: Tamburri et al., 2020.
Evaluation of efficacy and environmental impact from reactive in-water cleaning with capture

Evaluation of efficacy and environmental impact from **reactive in-water cleaning with capture**
Evaluation of efficacy and environmental impact from **proactive in-water cleaning**

Proactive IWC:
- Cleaning effectiveness
- Biocide release?

Modified from: Scianni and Georgiades 2019
Evaluation of efficacy and environmental impact from proactive in-water cleaning

Primary vessel:
• Start project immediately after dry dock
• 3x Biofouling/biofilm presence absence sampling
• 3x Water Quality sampling during cleaning

Secondary vessels (2):
• 1x Water Quality sampling per vessel during cleaning

Modified from: Scianni and Georgiades 2019
Evaluation of efficacy and environmental impact from proactive in-water cleaning

Proactive IWC:
• Cleaning effectiveness

Evaluation of efficacy and environmental impact from proactive in-water cleaning

Proactive IWC:
• Biocide release?

Water Quality Parameters:
• Biocides (Cu, Zn)
• TSS, POC, DOC
• Particle size distribution
• Microplastics

Modified from: Tamburri et al., 2020.
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Sample schedule for Primary Vessel:
- Dry dock and new coating: September 17, 2021
- Dive survey 1: October 2021 in Long Beach
- WQ sampling 1: November 2021 in Baltimore
- Dive Survey 2: March 2022 in Long Beach
- WQ sampling 2: March 2022 in Baltimore
- Dive survey 3: [TBD]
- WQ sampling 3: [TBD]
Next Steps

• Finish last two rounds of sampling for primary vessel
• Identify secondary vessels and conduct WQ sampling during proactive cleaning operations
• Produce public report and prepare manuscript for journal peer-review

• Use our experience to offer guidance to permitting agencies on important considerations (next slide)
Technical Considerations for Development of Policy and Approvals for In-Water Cleaning of Ship Biofouling

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Abstract

Submerged ship surfaces are often inhabited by diverse sessile and sedentary marine organisms, which can directly impact vessel operations and increase the likelihood of non-indigenous species (NIS) establishment and impacts. Ship-in-water cleaning (IWC) systems are now being incorporated into ballasting policy, and rigorous, transparent, and predictive verification testing is vital to regulatory success. Performance criteria for IWC approval should focus on environmental protection goals by including: qualified and independent testing; quantitative, robust, and statistically sound data, rather than qualitative observations; water sampling at all critical control points to characterize the release of harmful materials, including dissolved and particulate biofouling, measurable and protective endpoints, rather than pollutant reductions; determinations of presence or absence of macro-organisms, irrespective of species origin or physiological status; and approximately trained IWC operators.

Keywords: ship biofouling, biofouling, in-water cleaning, environmental regulations, verification testing

Introduction

The celebration of submerged surfaces by sessile and sedentary organisms, including microbes, invertebrates, and macrofauna, has long been a significant challenge for coastal and conserving ships. The World Health Organization (1972) identified the global shipping fleet, which is responsible for transporting approximately 80% of the world's goods and materials, as a primary target for the control of biofouling organisms. However, the current methods of biofouling control, such as ballast water treatment, have limitations and can lead to the establishment of non-indigenous species (NIS) in receiving waters. In response, the International Maritime Organization (IMO) has implemented the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) to prevent the spread of invasive species through ballast water exchange.

The IWC approach offers an alternative method for biofouling control by in-water cleaning (IWC) systems, which can be used to remove biofouling organisms directly from submerged ship surfaces. This approach is intended to reduce the transport of invasive species by providing an effective and environmentally sound alternative to traditional methods, such as ballast water treatment. The development of IWC systems requires rigorous testing and verification to ensure that they meet environmental protection goals and are capable of achieving their intended biofouling control objectives. This paper discusses the technical considerations for the development of IWC systems and the performance criteria for their approval.

Figure 2: Considerations of ship size in the development of in-water cleaning standards.

THANK YOU & QUESTIONS

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