Testing Ballast Water Technologies

a challenge for marine research in the Netherlands

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Introduction of Royal-NIOZ and history BWT activities

Why is NIOZ so unique for land-based testing

Collaborating partners

Mission of academic research institute in BWT testing

Standard-D2, CA and the NIOZ approach

Results (Hamann AG, Ecochlor & Hyde-Marine/LAMOR)

Future plans

Representing view of NIOZ and not necessary of NA’s
Royal Netherlands Institute for Sea Research

Zoological Station

1876

Texel - NIOZ

1970-present

Main building

harbour

Den Helder - Zoological Station/NIOZ

1890-1970

1876-2001

2001

2007
Why is NIOZ so unique for land-based testing

- testing since 2004; 2007 & 2008 Final/Type Approval tests
- 3 test series for Certification by NA, 16 companies pilot studies
- Tidal system with coastal water varying in salinity (24 – 30 PSU) and turbidity (10 - > 100 mg/l)
- Organisms diversity > 50 different species belonging to numerous genera
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The ultimate challenge: treating huge blooms of slimy phytoplankton
Partners

- Bundesamt für Seeschifffart und Hydr. German administration
- Marine Coastguard Agency (MCA)
- Dutch Min. Verkeer & Waterstaat (NL)
- Lloyds Register (London, Rotterdam)
- TNO-Imares, AquaSense (toxicology studies)
- VITENS (human pathogens)
- CaTO Marine Ecosystems Research and Manage
- KiTe ARC, GoConsult
- US-Coastguard
- NL-Royal marines
- GSI
- IMO/GESAMP
Mission academic research institute in BWT testing

- Public organization bound to publish all research in international peer reviewed journals
- Developing generic and specific tools and technologies
- Viruses, bacteria, phytoplankton and zooplankton (life stages)
- Holistic approach multiple tools to asses numbers and viability, applying state of the art tools and technologies
- Critical review of G8/G9 and legal aspects,
- Fundaments for future legislation based on acquired data
- Specialized studies of ‘silver bullets’
Mission academic research institute in BWT testing

- holistic approach multiple tools to assess numbers and viability
  - Microscopic counts (time consuming)
  - FlowCam; semi-automated (larger organisms)
  - Flow cytometry; automated (smaller organisms), including <10 μm (phytoplankton, bacteria, viruses)

- viability of remaining organisms but also vitality of discharged water
### Standard-D2, Ballast water management Act (US), CA-standard and the NIOZ approach

<table>
<thead>
<tr>
<th>Management approach</th>
<th>IMO Standard-D2</th>
<th>BW management -Act</th>
<th>2008 California Standard</th>
<th>NIOZ</th>
<th>nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Org. &gt; 50 µm</td>
<td>&lt; 10 viable/m³</td>
<td>&lt; 0.1 viable/m³</td>
<td>0 (/m³?)</td>
<td>n.d.</td>
<td>10²-10⁵/m³</td>
</tr>
<tr>
<td>Org. 10- 50 µm</td>
<td>&lt;10 viable/mL</td>
<td>&lt; 0.1 viable/mL</td>
<td>&lt; 0.01 viable/mL</td>
<td>n.d.</td>
<td>10-10⁴/mL</td>
</tr>
<tr>
<td>Org. &lt; 10 µm (phytoplankton)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n.d.</td>
<td>10-10⁶/mL</td>
</tr>
<tr>
<td>Bacteria</td>
<td>-</td>
<td>-</td>
<td>&lt; 10 cfu/mL</td>
<td>-</td>
<td>10⁵-10⁸ /mL</td>
</tr>
<tr>
<td>viruses</td>
<td>-</td>
<td>-</td>
<td>&lt; 10²/mL</td>
<td>-</td>
<td>10⁴-10⁸ /mL</td>
</tr>
<tr>
<td>n.d. = non-detectable</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td></td>
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</tbody>
</table>

Note: n.d. = no detectable; - = no standard
The forgotten fraction: Org. < 10 µm (phytoplankton)

Large number [± 40,000/ml] of phytoplankton cells 5 µm in diameter

A lot more phytoplankton cells than the size range of interests !!!!

Sample before treatment
Results: Interactions with stakeholders

- Intermediate between national administrations/IMO/ industry
- Define protocols for certification; required documentation, conducting land-based testing, data reports (ex/internal review)
- Legal aspects; transparent and sound data to be transferred into legally defendable results
- Trying to harmonize the requirement of different NA (Who is pushing the ON and OFF buttons)
Results: Interactions with stakeholders

- Improve and expand present set of (multiple) test protocols (active substances)
- Compare present standard(s) with current achievements
- Legal/statistical aspects of numbers and sample volumes
- (semi)automated analysis
  - TSS, POC, DOC, turbidity, salinity ~ 400 samples
  - Life -microscopy (> 10 µm) ~ 120 samples
  - Phytoplankton (PAM, FCM, micro) ~ 500 samples
  - Bacteria (counts, hum. Path.) ~ 500 samples
  - Viruses ~ 250 samples
- Total ~ 1770 samples
Test results
SEDNA-Hamann
Hyde-Guardian
Ecochlor

> 50 μm T0

> 50 μm T5

n.d.
Test results
SEDNA-Hamann
Hyde-Guardian
Ecochlor

10 - 50 μm T0

10 - 50 μm T5
Test results
SEDNA-Hamann
Hyde-Guardian
Ecochlor

~ bacteria standard

* = non-viable
Future plans

- Search for (innovative) tools addressing numbers & viability
- Test bed for innovative BWT technologies
- Transfer of academic knowledge into legislative process
- tools for examining efficacy of BWT systems, research regarding tools for compliance enforcement and monitoring (EU-project submitted; EU-Interreg North Sea)
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there is no wisdom without ballast