Can Ballast Water Treatment Affect Ship’s Life Cycle Cost?

Introduction of VOS System

Presented by:

Masahiko Ito
“Effective corrosion control in segregated water ballast spaces is probably the single most important feature, next to the integrity of the initial design, in determining the ship’s effective lifespan.”

Alan Gavin, Marine Director, Lloyd’s Register

“The life of a ship is determined by the life of the ballast tanks.”

Iver Iversen, Wilhelmsen Maritime Services
Which Ship Will Cost More at Next Drydocking?

VS.
Categories of Ballast Water Treatment Methods

1. Physical – Generally Not A Corrosion Concern
   Ultrasound
   Deoxygenation (Potential Corrosion Reduction)

2. Ultra-Violet Light (UV) – Generally Not A Corrosion Concern

3. Chemical
   A. Non-Oxidizing – Generally Not A Corrosion Concern
      Menadione
      Coagulant
   B. Oxidizing – Potential Corrosion Concern
      Ozone
      Chlorine Dioxide
      Chlorine
      Electro-chlorination (EC)
      Peracetic Acid/Hydrogen Peroxide
Oxidation and Ballast Tanks

ISSC studies have shown oxidizers to increase corrosion by 250%
Not All Oxidizers Are the Same

• Chemistry (e.g. Oxygen vs. Chlorine)
• Strength (Oxidation Potential)
• Dose (Total vs. Residual)
• Application (Salinity, pH, temp, TSS, TDS)
• Chemical Half-Life (affect only piping, or tanks also?)
• Breakdown Products: Total Residual Oxygen (TRO), Total Residual Chlorine (TRC)
• Biocidal Selectivity (vs. Coatings, Zinc, Steel, etc.)

<table>
<thead>
<tr>
<th>Oxidant</th>
<th>Oxidation Potential (in Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone</td>
<td>2.07</td>
</tr>
<tr>
<td>Hydrogen Peroxide</td>
<td>1.78</td>
</tr>
<tr>
<td>Chlorine Dioxide</td>
<td>1.57</td>
</tr>
<tr>
<td>Chlorine</td>
<td>1.36</td>
</tr>
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</table>
Ballast Tank Coatings

Ballast Tank Surface Area of Double Hull Ships

- Single Hull VLCC had 40,000 m$^2$
- Double Hull VLCC has 200,000 m$^2$

Cost to Coat and Repair – Imabari: Panamax Bulk Carrier ballast tank coating to PSPC will be $2,500,000 ($50/m$^2$)

New Performance Standard for Protective Coatings
- Target Useful Coating Life of 15 Years… But
- Section 4.1 – “The actual useful life will vary, depending on numerous variables including actual conditions encountered in service.”

Accelerated oxidation of retained solvents may reduce coating elongation, leading to premature embrittlement, flaking, cracking, etc.
Cathodic Protection

Zinc is uncoated and degradation rate is directly proportional to concentration of dissolved oxygen in ballast water.

High residual dissolved oxygen in ballast water will increase degradation of CP.

5 mA/m² = 1 kilo zinc per 7 m² of ballast tank surface area = 325 x 22 kilo zinc anodes for Panamax Bulker (approx. $500,000 at newbuild yard).

Oxidizing BWT may increase the required amount of zinc.
**Cathodic Protection (cont.)**

Low Oxygen Gas and Low Oxygen water can extremely reduce the damage of coating of Ballast Tank

→Decrease the corrosion of Tank and consumption of Zinc Anode

**TI Africa 1st Special Survey – 2007**

Since large ships can have over 1,000 anodes, this factor alone can save more money than the equipment cost of the VOS system.
TI Africa 1st Special Survey - 2007

- TI Africa: 4% O₂ Double-Scrub Cargo IG
- VOS System: 0.1% O₂ Double-Scrub Cargo IG

- CP Anodes Designed for 10% Remaining After 5 Years, but They Are 95% Intact
- Coating Breakdown Designed for 5% After 5 Years, but Only 0.5% Breakdown Observed
- No note of observed rust staining in ballast tanks.
- ABS Surveyor stated that he had never seen ballast tanks in such pristine condition after 5 years.
- How?
Plate and Structural Steel

CSR Predicted Corrosion Rate of 0.2 mm/yr does not account for BWT.

Should Corrosion Additions in ballast tanks be increased if a potentially corrosive ballast water treatment is selected?

Image Source: IACS CSR Council External Presentation, 12-06
What is the change to the cost of a ship if the ballast tank steel corrosion additions need to be changed? What if they need to be doubled?
# Example Illustration of Total Cost

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<th>Tank-Protective BWT Technology</th>
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<td><strong>10-yr BWT Running Cost</strong> <em>(Charterer)</em></td>
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<td>$700,000</td>
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<tr>
<td><strong>10-yr Ballast Tank Maintenance Cost</strong> <em>(Ship Owner)</em></td>
<td>$2,000,000</td>
<td>$1,000,000</td>
<td>$0</td>
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<td><strong>TOTAL</strong></td>
<td><strong>$2,200,000</strong></td>
<td><strong>$2,000,000</strong></td>
<td><strong>$1,300,000</strong></td>
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# Another Example

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Mitsubishi VOS System
How VOS Works

21% oxygen in air

OXYGEN IN EQUILIBRIUM

7 mg/l dissolved oxygen in seawater

BALLAST UPTAKE

<1% oxygen in treated tank headspace

TREATMENT EQUILIBRIUM

<1 mg/l dissolved oxygen in treated ballast water

Outside Ship Before Treatment

Inside Ship During Treatment

Outside Ship After Treatment

21% oxygen in air

OXYGEN EQUILIBRIUM RESTORED

7 mg/l dissolved oxygen in seawater

RE-OXYGENATION

BALLAST DISCHARGE
Mitsubishi VOS™ System

Image of De-Oxygen

Inert Gas

CO\(_2\)

Stripping

Low pH

O\(_2\)

(Untreated Water)
Works in Seawater, Brackish Water, Fresh Water Dirty, Hot, Cold Water

Low Oxygen Treated Water
Mitsubishi VOS System

<table>
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<tr>
<th>Pre Inerting</th>
<th>Ballasting</th>
<th>Topping Up</th>
<th>De Ballast + Inerting</th>
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- S. G. Generator
- Fuel
- Combustion Air
- Cooling Water
- Cooling Water Pump
- Over Board
- Sea Chest
- Ballast Pump
- Venturi
- Ballast Tank
- P-V Breaker
- P-V Valve
- Vent Valve
Mitsubishi VOS™ System
Shipboard Installation

• TECO/ MARY ANN HUDSON
• 32,000DWT BC

• 1000 m³/h IGG installed
• 500 m³/h x1 Ballast Pump

Outlook of Container installed IGG (Rear deck)
Owner and Yard Questions for Ballast Water Treatment System Suppliers

1. What does your treatment do to ballast water? (Chemistry)

2. What is the change to Oxidation Reduction Potential of this treatment? (Strength)

3. What is the required total and residual dose? (Dose)

4. How is the required initial dose affected by influent water chemistry? Does this have any affect on residual dose? (Application)

5. How long does the treatment chemical survive after dosing?

6. What are the breakdown products? Dissolved oxygen level?

7. Do you have proof that this treatment will have no negative affect on coatings, cathodic protection, or steel?
Suggestions for Shipyards and Ship Design Companies

1. Include structural and coating specialists in technical presentations by Ballast Water Treatment Equipment suppliers, not just piping team.

2. Demand information regarding treatment technologies’ affect on coatings, CP, and steel. MEPC 56: TRO, TRC info should be provided with application for evaluation [IMO Type Approval]

3. Consult with ballast tank coating suppliers about compatibility with ballast water treatment technology.


5. Design the ballast tank corrosion protection system (i.e., the ship’s structural protection system) to account for the affect of the ballast water treatment system.