The Silverstream® System – Air Lubrication
*The smart, verifiable, high impact efficiency technology*
Demonstrating the URN Co-Benefits of a Proven Energy Saving Solution

Silverstream Technologies
19-09-2023

Arno Dubois, Lead Hydrodynamicist
Presentation Overview

• Silverstream Technologies and the Silverstream® System

• Paper by Prof J.S. Carlton: ‘Ship Hull Air Lubrication: Aspects of Cavitation, URN and Propulsion’

• Developing a Pragmatic and Practical Approach to Demonstrate URN Co-Benefits of the Silverstream® System
Silverstream Technologies and the Silverstream® System
Air Lubrication – The Silverstream® System

• 5-10% net fuel and emissions savings
• Deployment of uniform carpet of air bubbles
  • Reduce frictional resistance (of flat of bottom)
  • Fluid shearing (unique feature)
  • Reduced shaft power + increased ship speed

• Fuel agnostic solution (energy savings regardless of fuel type)

• Simple installation
  • Newbuild and retrofit in regular dry dock period
  • Robust and elegant (including patented ARUs)
  • Control and automation based on ship speed / draught
### Demonstrated Savings – Verified Performance

‘If you can not measure it, you can not improve it.’ – Lord Kelvin

<table>
<thead>
<tr>
<th>Vessels Verified by Third-Parties</th>
<th>Net Savings In Power (NSP)</th>
<th>✓ Verified by</th>
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</thead>
<tbody>
<tr>
<td>H8091 LNGC 175k cum</td>
<td>5 6 7 8 9 10</td>
<td>HSLVA</td>
</tr>
<tr>
<td>Methane Patricia Camilla LNGC 168k cum</td>
<td>5 6 7 8 9</td>
<td>Shell</td>
</tr>
<tr>
<td>Diamond Princess Cruise 115k GT</td>
<td>3 4 5 6 7 8</td>
<td>Lloyd's Register, Wartsila</td>
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<td>ECO Valencia RoRo 7,800 LM</td>
<td>3 4 5 6 7 8</td>
<td>RINA</td>
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<td>Norwegian Joy Cruise 170k GT</td>
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<tr>
<td>Amalienborg Tanker 40k DWT</td>
<td>3 4 5 6 7 8</td>
<td>Lloyd's Register, University of Southampton</td>
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2014

TODAY
Paper by Prof J.S. Carlton
‘Ship Hull Air Lubrication: Aspects of Cavitation, URN and Propulsion’
Introduction to the Paper

• Authored by Prof J.S. Carlton (funded through EU Horizon 2020, project CHEK)

• Based on literature, experimental studies, and available sea trial data

• Formulates conclusions on the effect of air injection on
  • URN
  • Propeller radiated pressures
  • Propeller erosion
  • Propulsion

• ‘Translating’ of paper conclusions to ALS
‘Translating’ Paper to Silverstream® System

• Silverstream® System
  • Effective and efficient air delivery through fluid shearing
  • Presence of bubble carpet and air introduced into propeller

• URN reduction capabilities identified
  • Masking of shipborne noise emitted through the flat of bottom
  • Reduce noise levels generated by the propeller through the cushioning effect of emitted pressure pulses

• Develop a pragmatic and practical approach to conclusively demonstrate co-benefits
Developing a Pragmatic and Practical Approach to Demonstrate the URN Co-Benefits of the Silverstream® System
Research Methodology Development

• Currently, anecdotal evidence only

• Research approaches considered
  • First principles (including literature)
  • Experimental (lab)
  • Numerical modelling
  • Full-scale trials \(\rightarrow\) focus area

• Other considerations
  • Quantify performance of EET / ALS (trade-off vs co-benefit)
  • Relative vs absolute effects
  • Importance of regulations / class (notation) requirements

• Engage stakeholders (academic, industry, customers)
Initial Focus Area and Scope

• Need for pragmatic approach
  • Existing standards as basis (ISO17208-1/2 and ANSI/ASA S12.64)
  • Identified by stakeholder engagement
  • Can ‘proxy’ methodology be developed (on-board measurements)?

• Dedicated vs opportunistic measurements

• What’s next?
  • Intention declaration
    • Engage stakeholders (collaboration agreements)
    • Identify opportunities
  • Continued review and scope evaluation
    • System identification (ALS focused)
    • URN characterisation (noise sources, frequency ranges, acoustic characteristics, etc.)
    • Measurement tools (options, uncertainty, etc.)
  • Define scope of work for first project early 2024
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