1. GLOBAL SULPHUR CAP in 2020 & ALTERNATIVES

- ALT1: Low Sulphur Fuel Oil
  - No design modification
  - High OPEX: Low sulphur fuel oil
  - Catalytic fines issue

- ALT2: LNG fuelled Ship
  - CO₂ reduction & Tax credit
  - Environmental friendly
  - High CAPEX: LNG tank, FGSS, DF engine
  - LNG bunkering infrastructure

- ALT3: SOx Scrubber
  - Medium CAPEX
  - Open loop vs Hybrid
  - Corrosion issue

2. SCRUBBING PROCESS & ENVIRONMENT

- Exhaust gas
  - High temp.
  - Sulphuric

- Sea Water
  - Chloride

- Scrubbing Condition
  - Harsh & aggressive condition
  - Pitting, Crevice, Stress corrosion cracking, etc.
  - Reliable grade of corrosion resistant steel to be selected
    - SUS316 → Duplex → Super Duplex → 6 Mo → ...

3. MATERIAL SELECTION GUIDE

- STEP 1 – Listing up Potential Corrosion
  - Uniform
  - Hydrogen damage
  - Galvanic
  - Intergranular
  - Dukelaying
  - Erosion
  - Cavitation
  - Fretting
  - Corrosion fatigue
  - Crevice
  - Pitting
  - Stress-corrosion cracking

- STEP 2 – Defining Major Corrosion

- STEP 3 – Analyzing Working Condition

- STEP 4 – Material Selection by Material Selection Table

<table>
<thead>
<tr>
<th>Material</th>
<th>Stress Corrosion Cracking Temp. (°C)</th>
<th>Critical Pitting Temp. (°C)</th>
<th>Critical Crevice Temp. (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SU3516</td>
<td>60</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Duplex</td>
<td>100</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>Super duplex</td>
<td>110</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>6 Mo</td>
<td>120</td>
<td>70</td>
<td>40</td>
</tr>
<tr>
<td>Hastelloy</td>
<td>-</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

- Material having SCC temp. CPT, CCT beyond working temp. to be selected

4. DSME REFERENCE LIST

<table>
<thead>
<tr>
<th>Material</th>
<th>Maker</th>
<th>No. of Vessels</th>
<th>Type</th>
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<tbody>
<tr>
<td>300K VLCC</td>
<td>Wärtsilä</td>
<td>26</td>
<td>Open loop</td>
</tr>
<tr>
<td>319K VLCC</td>
<td>Alfa Laval</td>
<td>8</td>
<td>Open loop</td>
</tr>
<tr>
<td>23K TEU Container</td>
<td>Yara</td>
<td>5</td>
<td>Hybrid</td>
</tr>
<tr>
<td></td>
<td>Valmet</td>
<td>7</td>
<td>Hybrid</td>
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5. CONTACT NUMBER

<table>
<thead>
<tr>
<th>Name &amp; Position</th>
<th>Email</th>
<th>Tel.</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>

Total 46 References. DSME to provide the most reliable solution.