Green Technology Development
Alternative Fuel

Peng_guisheng@dsic-design.cn
09/02/2021
OUTLINE

01 Our Perspective on Green Technology

02 DSIC Green Technology Activities

03 Ammonia Fuel Solution for 23,000TEU
1. Our Perspective on Green Technology

- **Alternative Fuel Technology**
  - Alternative fuel technology is most effective way to achieve IMO mid-term target
  - In 2050, abt. 64% of the total amount of CO2 reduction is contributed to by use of alternative fuels
  - Considering marginal cost of alternative fuel is relatively high, energy-saving solution is also critical for future shipping.

- **Energy Saving Technology**
  - Wind Propulsion
  - Air Lubrication
  - Low Friction Hull Coating
  - Energy-saving device for rudder & propeller and etc.
2. DSIC Green Technology Activities – Delivered Project

- **World First VLCC with Wind Sailing System Delivered on Nov. 2018**
  - 12knots, Laden Condition, Middle East - Far East
  - Considering global wind resources
  - Average energy saving abt. 5%

- **Second Generation, to be Delivery on Sep. 2022**
  - Two pairs, energy saving abt. 10%
  - Composite material applied, cut 30% weight
  - Real-time analysis system and structure healthy monitoring system applied
  - Optimized control strategy
2. DSIC Green Technology Activities – Ongoing Project, to be delivered in 2021

- World First VLCC with LNG Power
  - Innovative collaboration with COSCO Shipping
  - Equipped with 2 Type C Tanks: 3500m³ x 2
  - Endurance: 24,000 nm (12,000 nm LNG as fuel)
  - Attained EEDI Phase III

Research on

- Propulsion System
- Fuel Gas Supply System
- Gas Storage System
- Auxiliary System
3. Ammonia Fuel Solution for 23,000TEU

- Development Story

  - Kick-off in March 2019
  - AiP certificate granted by LR in Shanghai Dec. 2019
  - Design further developed in 2020
3. Ammonia Fuel Solution for 23,000TEU

- The Closest Alternative to an Ideal Fuel, Ammonia
  - Carbon free, Easily reformed to H₂ and N₂
  - Can be stored and transported as liquid at relatively low pressure or high temperature
  - Low flammability risk — 15-25% in air
  - Higher energy density than Hydrogen per cubic meter

Global energy consumption and CO2 emissions in international shipping in the Sustainable Development Scenario, 2019-2070

Ammonia as fuel is most promising solution
3. Ammonia Fuel Solution for 23,000TEU

Main propulsion

- Based on MAN 11G95ME-C10.5-LGIP(A)
- Biodiesel for pilot and standby
- (Crack ammonia to get hydrogen to ignite)

Electricity

Generator burning NH3/Biodiesel

- Assuming there will be marine generator burning NH3 soon later
- Use biodiesel for Generator sets

Shaft generator + CPP

Shaft generator combined with CPP to use the power of main engine from low load to high load.

Shaft generator + gearbox + FPP

Shaft generator combined with gearbox to use the power of main engine from low load to high load.
3. Ammonia Fuel Solution for 23,000TEU

- Endurance for NH₃ as Fuel
  - Multiple refueling can be realized along route in near future
  - Maximum container intakes
  - Cost efficiency

<table>
<thead>
<tr>
<th>Speed</th>
<th>20.5 knots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>19,500 m³</td>
</tr>
</tbody>
</table>

Satisfy with single trip endurance

Voyage from Asia to Europe

Source: DNVGL
3. Ammonia Fuel Solution for 23,000TEU

- High capacity utilization
- Suitable for -34°C design temperature
- Low cost
- Widely used on LPG tankers

- Design pressure: 0.7 bar
- Design Temperature: -34°C
- Density at design temperature: 700 kg/m³
- Material: LT-FH32 or equivalent
- Net Volume: 19,500 m³
3. Ammonia Fuel Solution for 23,000TEU

- Low-Flashpoint Fuel Supply System (LFSS)

- Supply: Liquid 70bar, 25~55°C
- BOG: Reliquefaction plants
- Safety:
  - Monitoring
  - Ventilation
  - Water sparking system
  - Personal protection apps.
3. Ammonia Fuel Solution for 23,000TEU

- Low-Flashpoint Fuel Supply System (LFSS)

- Vent mast
- Re-liquefaction room
- Bunker Station
- Vent mast
- LFSS room
- Pathway
- Fuel tank
3. Ammonia Fuel Solution for 23,000TEU

- **Economic Discussion**

**CAPEX:**

<table>
<thead>
<tr>
<th>ITEMS</th>
<th>LNG DUAL FUEL</th>
<th>C-FUTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN ENGINE</td>
<td>12X92DF</td>
<td>11G95ME-C-LGI(A)</td>
</tr>
<tr>
<td>DIESEL GENERATOR</td>
<td>-</td>
<td>5000kWx1</td>
</tr>
<tr>
<td>LNG DF GENERATOR</td>
<td>3690kWx4</td>
<td>-</td>
</tr>
<tr>
<td>SHAFT GENERATOR</td>
<td>-</td>
<td>5000kWx2</td>
</tr>
<tr>
<td>FUEL STORAGE TANK</td>
<td>MEMBRANE OR TYPE B</td>
<td>TYPE A</td>
</tr>
<tr>
<td>FUEL SUPPLY SYSTEM</td>
<td>LOW PRESSURE LNG SUPPLY</td>
<td>HIGH PRESSURE NH3 SUPPLY</td>
</tr>
<tr>
<td>SHAFT AND PROPELER</td>
<td>FPP</td>
<td>CPP</td>
</tr>
</tbody>
</table>

**OPEX:**

<table>
<thead>
<tr>
<th>Fuel (ton/day)</th>
<th>Fuel (ton/year)</th>
<th>Carbon Emission (ton/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG</td>
<td>129</td>
<td>33540</td>
</tr>
<tr>
<td>NH3</td>
<td>301.1</td>
<td>78300</td>
</tr>
</tbody>
</table>

Fuel consumption and carbon emission at 18 knots. Depending on the fuel price and carbon emission cost.

-9,000,000 USD
Issues for Ammonia Fuel Application

- Policy
- Rules and regulations
- Production capacity and scale
  - Enough to support energy consumption demand
- Bunkering flexibility
  - Bunkering facilities to be developed early
- Toxic and personal safety
  - Suggest to develop flexible protected equipment for human proximity
- NH₃ price
  - Decide investment in the short term.
- Difficult decision for ship owner
  - Build a ammonia fueled ship now or just ammonia ready for future conversion
Thanks for your attention!