STEADY THE SHIP

Lorenz Claes, GTT, France, and Mei Rongbing, DSIC, China,
discuss the benefits of a ballast-free LNG carrier design.

The majority of merchant vessels worldwide use ballast water when the ships are empty or partially loaded in order to maintain seaworthy conditions. This ballast water is needed to reach sufficient draft for propeller immersion and to avoid excessive bow-slamming. However, this implies investment in related systems and substantial operating costs. In addition, the vessel's operation can be impaired by the quantities of cumulated sediments at the bottom of the ballast tanks. On the environmental side, transporting ballast water leads to the risk of transferring harmful aquatic organisms and pathogens if ballast is discharged in the arrival port during the cargo loading operations.

Why use ballast water?

Solid ballast was originally used in sailing ships to increase stability by lowering the centre of gravity and increasing the righting moment. In today's full formed (high block coefficient) merchant ship designs, ballast water is required to be carried on unladen voyages to increase the draft and to adjust the trim. Without sufficient ballast to achieve a deeper draft, typical designs are at risk of forefoot (bow) slamming in a seaway, which can result in structural damage. Also, without ballast, typical designs will have insufficient propeller immersion to achieve efficient operation (both in calm water and a seaway), or, alternatively, the propeller diameter would need to be reduced to achieve suitable immersion in unladen condition, which, in turn, is less fuel-efficient than a larger diameter propeller.

The use of ballast water is costly

The carriage of water ballast brings with it many additional technical and commercial challenges. Some of the challenges include the following:

- Increased construction costs owing to additional machinery and systems (pumps, piping, valves, treatment system, corrosion resistant coatings for the ballast tanks).
- Increased maintenance costs through life of the machinery and systems listed above, and the ballast tank anti-corrosion coatings monitoring.

- Increased operational costs due to additional energy/fuel consumed by ballast pumping operations, ballast water treatment systems, sediment accumulation in the ballast tanks, etc.
- Increased fuel consumed during ballast voyages (compared to a loading condition carrying less or no ballast).
- Increased risk of regulatory compliance issues related to the ballast water treatment systems.
- Compliance with PSPC regulation (IMO Performance Standards for Protective Coatings) requirements for the painting/corrosion protection of ballast tanks.

Due to its availability and ease of use, local water has been used as ballast for years. However, the ballast water loaded on ships contains a lot of local sea or river life, which not only becomes a threat in the area where it is discharged, but also increases the wear and tear of the ballast tanks and its equipment. Therefore, a ballast tank needs to be regularly inspected. This is a sensitive operation that requires specific permit to work and inspection measures. In addition, it can only be done when the ballast tank is empty and the ship is not sailing. Potential issues identified during inspections are as follows:

- Paint damage leading to fast corrosion of the steel hull.
- Heavy corrosion of the valves and actuators leading to early wear and tear of equipment or even hydraulic leakages with oil contamination of the ballast water.
- Mud or sediment accumulation adding extra weight (causing extra fuel consumption) and preventing steel hull thickness surveys.

In addition to the ballast tank itself, specific machinery equipment is to be installed and regularly overhauled.

Figure 1. 28 000 m^3 B-Free LNG carrier (credit: DSIC).

Figure 2. 28 000 m^3 B-Free LNG carrier (credit: DSIC).

- Powerful seawater pumps made of strong and highly corrosion resistant material and with sufficient capacity to cover the highest discharge rate possible of the ship. Depending on the ship's size, pumps are heavy, have expensive spare parts and significant power consumption.
- Since the new International Convention for the Control and Management of Ships' Ballast Water and Sediments (the Ballast Water Management or BWM Convention) was ratified (see paragraph below), a ballast water treatment system (BWTS) needs to be installed. This installation requires investment, space on board, and needs to be closely monitored to ensure the compliance of the ballast water (dis)charged. Like the pumps, these treatment systems are also significant energy consumers.

BWM Convention

The transfer of invasive marine species into new environments via ballast water has been identified as one of the major threats to the world's oceans. In response, the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992, in its Agenda 21, called on the International Maritime Organization (IMO) and other international bodies to take action to address the problem.

In February 2004, the IMO adopted the BWM Convention to regulate discharges of ballast water and reduce the risk of introducing foreign species from ships' ballast water. To complement the BWM Convention, the IMO adopted over 15 sets of guidelines and other documents contained in its Marine Environmental Protection Committee (MEPC) resolutions and circulars. The BWM Convention is now effective. It requires a BWTS for newly built ships, and, after a possible extension of two years, on all operating ships.

In response to this, a number of technologies have been developed and commercialised by different vendors. These systems must be tested and approved in accordance with the relevant IMO guidelines. Although most ships are expected to comply by installing a BWTS on board, some of them will conform by using one or more of the alternative methods due to technical and commercial considerations.

The recent introduction of regulatory requirements imposing the installation and usage of BWTSs has shifted the balance point between the benefits and disadvantages of ships designed to carry ballast water. Ships will be more and more costly and complicated to operate.

Concerned by the severe environmental impact, the IMO has recently adopted the BWM Convention dealing with this major global problem. The convention has been effective since 8 September 2017. It requires a BWTS to be installed on all new ships built after the effective date and on all existing ships no later than a ship specific date that will fall between September 2019 and September 2024.

The ballast-free concept is one of the options

Several attempts to fully remove or at least reduce the need for ballast water have been made in the past for various ship types. However, the previous developments have not progressed to a phase of full technical and contractual maturity.

Aware of the considerable advantages for ships not using ballast water, GTT, Lloyd's Register, DSIC, and EXMAR decided to join forces in order to study this subject again. Considering the growing global demand on LNG, the target is a new generation of efficient and environmentally friendly ballast-free LNG carrier design, aiming to fully eliminate the ballast water carried on board. The project was presented at Gastech in September 2018 in Barcelona, Spain.

Environmental progress and economic efficiency are the key drivers.

The advantages of a ballast-free vessel are numerous, in terms of investment, operating costs and maintenance, simplification of the vessel's operation, reduced corrosion, and prolonged lifetime.

Key advantages and savings as far as CAPEX is concerned are as follows:

- Eliminate the BWTS: i.e. the cheapest rule compliance.
- Eliminate the ballast systems: pumps, pipes, valves, sounding and vent-pipes, controls, sea-chest size reduction, etc.
- Replace all ballast tanks with void spaces, which will:
  - Reduce the costly ballast tank coatings.
  - Cancel the need for anodes in ballast tanks.
  - Reduce the steel scantlings requirements due to overflow pressure height in ballast tanks.

In addition to all of the CAPEX savings mentioned above, the following explain why substantial OPEX savings will be made during the ship's lifetime:

- Reduced man-hours spent for tank inspection and equipment overhauls and repairs (probably the most important OPEX saving).
- Extended vessel service-life due to drastically fewer corrosion issues.
- Reduced fuel consumption for the propulsive power.
- Reduced fuel consumption as running equipment, such as pumps, BWTSs or even a hydraulic system for the remote operated valves, are not installed onboard any more.
- Eliminated the use of electrical power for (de)ballasting.
- No maintenance and replacement costs for ballast water pumps and valves:
  - Reduced spare parts requirements.
  - Reduced operational failure risk on BWTS.
- Eliminated the issue of sediment accumulation in ballast tanks: no cleaning works, less corrosion, better and easier inspection.
- Simplified vessel operation and crew life.
- Reduced boil-off rate.

These OPEX advantages will increase the adaptability of this ship, especially for coastal trades with frequent calls in major rivers, where the operators can benefit greatly from the ballast-free design. Furthermore, additional positive outcomes are expected:

- The vessel's course-keeping capability will be improved due to the new hull design.
- The slamming impacts in heavy weather will be reduced, and seakeeping will be improved.
- The issues relating to local sea life protection are completely eliminated. **LNG**