BRICK BY BRICK

Guillaume Gelin, GTT, France,
discusses how membrane technology can be competitive for small capacities.

LNG Brick® is a package for storage of gas for propulsion dedicated to ships requiring a small quantity of LNG (less than 3000 m^3). It includes storage and the gas preparation room. LNG Brick® is delivered as a block ready to be integrated into the ship structure.

Cost cutting

The first step is standardisation. The LNG Brick® concept is intended to keep the design as simple as possible without jeopardising a customer's requirements.

Unlike the typical membrane design that allows complex geometries, LNG Brick® is limited to cubic tanks, which limits the number of references and simplifies its erection. Besides, the tank will keep full flexibility on its three main dimensions (length, breadth, height) thanks to a specific arrangement and a 'set-up area' (see Figure 2). When a cubic design is required, this means that the tank can be adapted to the exact dimensions required by the vessel arrangement.

The reduction of the number of references is possible thanks to a new panel arrangement where a set-up area is located in the middle of the tank. The panel arrangement outside this set-up area is standard and will contribute to reducing the required engineering for the membrane design.

Below 3000 m³, a lot of LNG fuel tanks will be installed in a box space with rarely any need for complex geometry. Of course, current membrane technologies remain more relevant for projects requiring complex shapes in order, for example, to optimise the LNG fuel tank capacity.

A second step is to concentrate the construction of LNG Brick® on companies already experienced in membrane erection. As an order of magnitude, in a suitable location it can take a skilled team up to three times less time to erect a membrane tank compared to newcomer crews working in a location where working constraints are complex. In this way, construction cost will be significantly reduced. Moreover, by concentrating the erection on a limited number of companies, investment in tools and training of welders and bonders will be amortised on more projects, leading to a dilution of fixed cost.

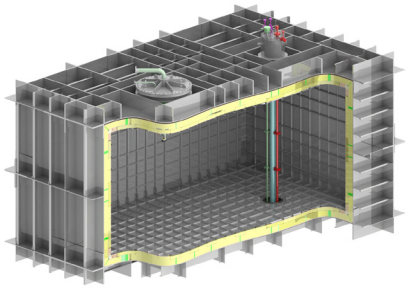

Figure 1. LNG Brick®.

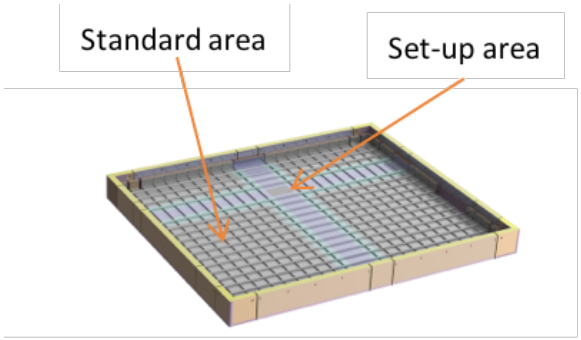

Figure 2. Membrane erection principle.

Figure 3. LNG Brick® prototype.

Last but not least, since the LNG tank will be delivered already outfitted and tested, no specific knowledge on the membrane will be required by the shipyard. This new technology is therefore very accessible and any shipyard could consider it.

Operational flexibility

LNG Brick® has also been designed to bring operational flexibility in simplifying pressure management and increasing autonomy.

Firstly, LNG Brick® boasts a high volumetric efficiency. For instance, compared to independent type C tanks, it is possible to load 50 – 100% extra LNG fuel in the same given space. It means that the vessel autonomy could be significantly increased, allowing operational flexibility and extended availability of the vessel. Therefore, the ship-owner will have more options when considering its bunkering strategy.

The maximum setting pressure of LNG Brick® is increased in order to ensure more than 15 days of holding time (tank closed). Since the IGC code and now the IGF code historically limit the maximum pressure in the membrane tank to 0.7 barg, the main challenge of this pressure increase has been the regulatory aspect. GTT has demonstrated with class societies the feasibility and has now been endorsed by approvals in principle from DNV, ABS, LR, and BV. Moreover, last December, a pressure test under cryogenic conditions was performed on the LNG Brick® prototype, demonstrating the full membrane ability to sustain an increased vapour pressure. In fact, the pressure at the bottom of

Figure 4. Pressure test in cold condition.

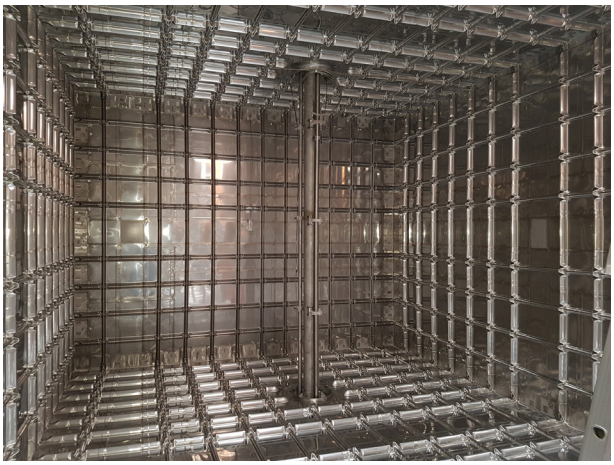

Figure 5. Membrane erection principle.

an LNG fuel tank will remain at the same order of magnitude as the pressure at the tank bottom of the largest LNG carriers (with lower operating pressure but higher hydrostatic pressure due to higher tank height).

In addition, LNG Brick® is also fitted with a sump to minimise the unpumpable LNG at sea. Indeed, at low filling levels with liquid motions the inlet suction can briefly emerge out of the liquid causing the pump to trip. A sump will ensure that the inlet remains submerged, guarantee good behaviour with low filling level and increase the usable capacity of the tank.

Liquid motion in tanks

Sloshing analysis has been performed and, since the quantity of LNG involved and the tank breadth remain low, no specific design is required whatever the filling level.

All in all, the operators will have full freedom to operate the tank between 0% and 95% with no restriction on intermediate fills.

Reliability

LNG Brick® is based on the Mark III membrane technology with some slight modifications, notably in order to simplify design and erection. Mark III is already fitted today in over 150 LNG carriers around the world and boasts an excellent track record.

Prototype

An LNG Brick® prototype has been built in order to demonstrate tank performance such as boil-off rate and holding time, and to give a test platform able to demonstrate LNG Brick®'s relevance for smaller LNG fuel tanks. The aim of this prototype was also to identify and put in place cost reduction actions in adapting, for example, erection procedures to small tanks.

The tank dimensions are 10 m x 5 m x 4 m (LxBxH), with a capacity of 115 m^3.

The steel structure has been tested with an hydrotest at 2.6 barg prior to membrane erection. Once the membrane was completely erected, the usual tests were performed to ensure membrane integrity and tightness of primary and secondary membranes under cryogenic conditions.

Moreover, the construction of the tank was carried out in six months and confirmed the short schedule required to build a membrane tank. An action plan has also been put in place to reduce the delivery time even more. All in all, leadtime for forthcoming applications should be between 6 – 12 months depending on tank size.

Future applications

LNG Brick® technology is mainly dedicated to vessels with high space constraints where cubic geometry makes sense such as for ferries, roros, and container vessels. It will contribute to significantly increasing the autonomy in gas mode with a minimum impact on cargo capacity.

In case of a project, a first step will be to determine the exact tank dimensions optimising the vessel arrangement. Then, the steel structure design and membrane arrangement will be determined during the engineering phase. At this stage, GTT will quickly define the number of standardised components in order to launch the panels and membranes fabrication as soon as possible. Once the validation is completed and the components are fabricated, GTT industrial partners will be in charge of the tank construction, membrane erection, and tests.

Finally, the LNG Brick® will be delivered to the shipyard, ready to be integrated inside the vessel under construction. LNG