A custom fit

Jörg Müller, TGE Marine Gas Engineering, Germany, discusses the importance of designing tailor-made LNG storage tanks onboard vessels.

This has been never done before. 44 000 kW of power generated by LNG onboard the world's biggest crane vessel. In the middle of June 2019 in the South China Sea, a team of TGE Marine Engineers returned from the successful commissioning of the LNG fuel gas system onboard the Sleipnir crane vessel.
Crane vessel *Sleipnir* – eight columns into the future

A new generation of tailor-made LNG fuel gas systems have been introduced as TGE Marine was awarded a contract to supply the LNG fuel gas system for HEEREMA’s new semisubmersible crane vessel (NSCV), *Sleipnir*. Not only are the ship dimensions gigantic; so too is the LNG fuel gas system. Eight vertically installed IMO Type C tanks with a total capacity of 8800 m³ were installed. Each tank is equipped with two LNG submerged pumps providing LNG to the four independent LNG fuel gas systems. Each fuel gas system is providing fuel to one of four engine rooms. For reasons of redundancy, a second engine room can be served with 100% capacity. With these parameters, the LNG fuel gas system for the *Sleipnir* is the biggest fuel gas system worldwide with regards to LNG storage and output capacity.

To meet the safety requirements of International Maritime Organization (IMO) codes and classification societies, LNG, or rather gas piping below the deck of a ship, needs to be double-walled, either with vacuum or ventilated inner space, depending on the application. More than 1 km of double-wall piping has been installed onboard of the *Sleipnir*, provided by TGE Marine.

**How it all began**

A large portion of global trade is transported at sea with the resulting consequences for the environment gaining ever more awareness over the last few decades. Therefore, there is no doubt about the necessity for clean and sustainable propulsion systems for ships. Designers, shipbuilders, shipowners and charterers are looking for the best solutions to fulfill existing and upcoming regulations on NOₓ and SOₓ emissions, for example. In commercial and environmental terms, using LNG as fuel is the best way to significantly reduce SOₓ, NOₓ and particle emissions by simply using clean fuel instead of employing complex exhaust cleaning systems.

The LNG fuel story started for car and passenger ferries in Norway supported by local tax incentives. The increasing number of conversions and newbuilds with LNG propulsion are now demonstrating that LNG as fuel is the perfect application for ships trading within emission control areas (ECAs). The first years of LNG fuel gas systems were characterised by vacuum insulated tanks installed on the open decks of vessels. Most of the system suppliers soon started to standardise their systems. The advantages were clear: system dimensions were covered from the very start. Therefore, for a while, it was common to build a ship around the LNG tank.

This approach collapsed partly as car carriers and containerships started considering LNG as an environmentally friendly fuel on their journeys within the North and Baltic Sea, or within the coastal waters of the US. For such ship types, the typical places for a vacuum insulated tank could not be used anymore.

Fuel gas system providers like TGE Marine are therefore now being asked for tailor-made solutions and to build LNG fuel gas tanks for ships, rather than the other way round. One leading project has been the two pure car and truck carriers for UECC commissioned in 2016. TGE Marine designed the 800 m³ LNG fuel gas tank tailor-made according to the available space provided by the shipyard. The high pressure LNG fuel gas system serving the MAN ME-GI two stroke engine, and the low pressure LNG fuel gas system serving the auxiliary engines, have been designed in a maintenance friendly fashion in the adjacent compartments.

**Space is an issue**

The next innovative step was taken just a few years later. In December 2018, the first of a series of six 1400 TEU containerships went into service. In close cooperation with the ship designer and owner, TGE Marine developed the space saving vertical tank design. With this solution, only minor modification of an existing ship design was necessary. This application has progressed even further with the earlier mentioned *Sleipnir* NSCV.

**Tailor-made conversion projects**

A compromise of standardised and tailor-made solutions was used on the conversion of the *Bergen Viking*, an oil tanker trading on the rough seas around Norway. TGE Marine selected a vacuum-insulated tank from a well-established tank manufacturer with a so-called tank connection space (TCS) at the front of the tank. This TCS contains the tailor-made LNG fuel gas system to meet the special requirements of the engine maker, who installed pure gas engines. Since diesel has not been available as a backup fuel, further means for failsafe performance and redundancy have been successfully implemented.

The 1000 TEU containership *Wes Amelie* of the German shipowner Wessels also demonstrated the successful realisation of a conversion project. The main difference to a newbuilding is typically the missing space for the LNG tank and the fuel gas systems for ships.
equipment. Accordingly, naval architects of TGE Marine have been deeply involved in the integration of the fuel gas system into the existing vessel design.

**From gas carrier to LNG bunker ship**

But innovations in the LNG as fuel market are not limited to LNG fuel gas systems onboard ships. Innovative solutions have also been implemented on the bunkering vessel side.

The most recent milestone has been the ship-to-ship (STS) bunker operation of the *AIDAnova* by the *Coral Methane*, which has been converted to an LNG bunker vessel by its owner Antony Veder, supported by TGE Marine. The *Coral Methane* was originally delivered 10 years ago as a combined ethylene and LNG transportation vessel based on TGE Marine’s cargo handling system and ship design.

**Support to the shipyards**

A number of shipyards are now offering vessels with LNG propulsion systems and are being confronted with the challenge of installing cryogenic gas systems on board, for example, merchant and passenger vessels, which was formerly a domain of specialised yards in the gas carrier sector. Therewith, the requirements relating to the fuel gas system suppliers have changed as well. At the beginning of 2018, Keppel AmFELS (US) selected TGE Marine for the construction and supply of a high pressure LNG fuel gas system for two containerships to be operated by the US owner Pasha. This is the second project for TGE Marine involving the delivery of high pressure LNG fuel gas systems to shipyards in the US, further to two ConRo vessels for Crowley (US) built at VT Halter (US).

Extensive skid and unit prefabrication of the LNG tanks, fuel gas system and bunkering station will be provided to reduce the installation effort for the shipyard.

**Innovative tank design for conversion**

A high potential market segment for LNG-conversion is the worldwide fleet of container vessels that will stay in service for decades to come. Just in time for the Nor-Shipping 2019 exhibition in Oslo, TGE Marine presented an innovative tri-lobe design for a Type C LNG fuel gas tank. This tank has been designed to fit into one container bay of a medium or large container vessel, following the ship structure. Three cylinder sections are designed in a horizontal transversal arrangement to form three lobes in a single tank. The focus of this design was to gain volume efficiency while maintaining all the advantages of an IMO Type C tank (pressure holding capability and ease of operation). Depending on the ship size, this tank is able to contain up to 7000 m³ of LNG. This tank will be tailor-made, prefabricated and delivered to the conversion shipyard ready for installation. The related fuel gas handling system will be provided on skids for easy and fast installation. The prefabrication of this module limits the costly dockyard time significantly.

**Conclusion**

LNG as fuel began its successful story as a clean ship fuel for the future more than 10 years ago. The increasing number of ships using LNG and their special requirements are creating challenges for both the shipyard and the fuel gas system suppliers. The installation of simple, cylindrical LNG tanks only caters for a limited market segment. Specialised and tailor-made solutions for LNG fuel gas tanks are being requested for an increasing number of different applications for LNG as fuel on newbuild ships, as well as on conversion projects to LNG propulsion. In this process, shipyards do not want to dispense of the advantages of ready-to-install equipment. Therefore, prefabrication of fuel gas units, such as fuel gas tanks and supply systems, are requested by the market. TGE Marine is well prepared for the new challenges in this market.