

DEVICE FOR FLOATING PRODUCTION OF LNG AND METHOD FOR CONVERTING A LNG-CARRIER TO SUCH A DEVICE

TECHNICAL FIELD

5 The present invention relates to a device for floating production of LNG and a method for converting an LNG-carrier to a device for floating production of LNG.

BACKGROUND

10 For transport of natural gas to distant markets the gas can be converted into LNG (Liquefied Natural Gas) and shipped at sea by means of LNG carriers. To date more than 280 LNG carriers have been built world wide. Due to the low temperature of the cargo (-163°C) the cargo containment system on an LNG carrier is a complex and costly installation. Over the years considerable efforts have been made by designers and shipyards to optimize the technology and reduce cost of the LNG carrier containment systems.

15 The LNG carrier market has been and still is completely dominated by two containment system designs; the Moss spherical tank and the membrane design.

20 In the recent years concepts have been proposed for creating floating LNG production units, often referred to as "an FLNG unit" or "an FLNG". Such a unit is provided for offshore production of LNG. In comparison with LNG carrier designs the amount of equipment needed on an FLNG unit will be substantial. Since the ship hull and LNG storage tanks on an LNG carrier are optimized for transport of LNG, installation of LNG production equipment may be difficult or even impossible without significantly affecting the design of the ship hull and/or the LNG storage tanks. In response to this challenge FLNG concepts have been proposed with LNG storage tank designs being different from the dominating Moss and membrane designs. The construction of these alternative systems is associated with additional risks and costs compared to the dominating LNG carrier designs

25 The object of the present invention is hence to provide a system and method for floating production of LNG which can benefit directly from experience with LNG carriers. Moreover, the object of the present invention is to provide a method for converting an LNG-carrier to a device for floating production of LNG.

SUMMARY OF THE INVENTION

30 The present disclosure relates to a device for floating production of LNG, comprising:

- a LNG carrier comprising a ship hull and at least one spherical LNG storage tank for storing LNG;
- a projecting hull structure fixed to the ship hull;
- a LNG production system for converting natural gas to LNG, where the LNG production system is arranged in the projecting hull structure;
- means for transferring LNG from the LNG production system to the at least one spherical LNG storage tank.

In one embodiment, some elements of the LNG production system is arranged in the ship hull.

- 10 In one embodiment, the hull structure is fixed to the outer side surface of the hull of the LNG carrier.

In one embodiment, the ship hull and the hull structure is an integral structure.

In one embodiment, the hull structure is welded to the ship hull.

- 15 In one embodiment, an upper surface of the hull structure is substantially level with the main deck of the LNG-carrier.

In one embodiment, the hull structure is arranged above the water level of the ship hull.

In one embodiment, it comprises means for receiving natural gas from an external source and means for conveying the natural gas to the LNG production system.

- 20 In one embodiment, the hull structure is watertight.

In one embodiment, the hull structure comprises buoyancy compartments.

In one embodiment, the hull structure and the LNG production system are provided to be retrofitted to the LNG carrier.

- 25 The present disclosure also relates to method for converting an LNG-carrier to a device for floating production of LNG, where the LNG carrier is comprising a ship hull and at least one spherical LNG storage tank for storing LNG, wherein the method comprises the following steps:

- providing the ship hull of the LNG-carrier with a protruding hull structure;
- arranging an LNG production system in the protruding hull structure;
- 30 - connecting the LNG production system to the at least one spherical LNG storage tank.

In one embodiment, the method comprises fixing the hull structure to the outer side surface of the ship hull.

In one embodiment, the method comprises welding the hull structure to the ship hull.

- 5 In one embodiment, the method comprises retrofitting the hull structure and the LNG production system to the ship hull.

In one embodiment, the method comprises providing the hull structure above the waterline of the ship hull.

DETAILED DESCRIPTION

- 10 In the following reference will be made to the enclosed drawings, as follows:

Fig. 1 illustrates a plan view of a typical Moss type LNG carrier with four spherical LNG tanks.

Fig. 2 illustrates a plan view of an FLNG unit based on the LNG carrier in fig. 1.

- 15 Fig. 3a and 3b illustrate transverse sections of different embodiments of the FLNG unit.

Fig. 4 illustrates an alternative embodiment of fig. 2, also showing elements of the LNG production system.

- 20 Fig. 1 illustrates the general arrangement of a typical Moss type LNG carrier 1. The LNG carrier is used for storing of LNG. 1. The LNG carrier 1 comprises essentially a ship hull 2, in which spherical LNG storage tanks 3 are provided. The LNG carrier 1 is considered well known for a skilled person and will not be described in detail herein. In the embodiment shown in fig. 1, the LNG carrier 1 comprises four spherical LNG storage tanks 3.

- 25 It is now referred to fig. 2, illustrating the present invention as a device 11 for floating production of LNG (i.e. an FLNG). As in fig. 1, the device comprises an LNG carrier comprising a ship hull 12 and at least one spherical LNG storage tank 13 for storing LNG.

- 30 The device 11 may be utilized as a more or less stationary floating unit anchored to the seabed or positioned by DP; where natural gas is converted to LNG on the device 11 and where the tanks 13 are used as temporary storage. In such use, the LNG will be transported to the marked by means of other transport vessels that fills their LNG tanks from the tanks 13 of the device 11. However, the device 11 may also comprise a propulsion system 14 for transportation of the LNG.

The device or FLNG 11 further comprises a projecting hull structure 16 fixed to the ship hull 12. The projecting hull structure 16 is denoted a so-called sponson structure, which is a term used to describe structures that project from the side of a ship. The sponson structure 16 may be fixed to the outer side surface of the hull of the ship hull, for example, the sponson structure 16 may be welded to the ship hull 12. Hence, the sponson structure 16 is suitable for being retrofitted to an existing LNG carrier.

The ship hull 12 and the sponson structure 16 may also be arranged as an integral structure, for example if the entire FLNG is built as a new structure.

As shown in fig. 2 and fig. 3a-b, the sponson structure 16 comprises two structures, one sponson structure on each side (starboard and port side) of the ship hull 12.

As shown in fig. 3a and 3b, the upper deck of the sponson structure 16 may be at the same elevation as the main deck of the ship hull. In fig. 3a it is shown that the sponson structure 16 is arranged above the water level A of the ship hull 12.

Consequently, the sponson structure 16 may be retrofitted to an LNG carrier without the need for a dry dock during the retrofitting process.

However, it would also be possible to arrange the sponson structure 16 so that it is entirely or partially below the water level A, as indicated in fig. 3b.

The sponson structure 16 may be watertight. Hence, the sponson structure 16 contribute to the buoyancy and hydrostatic stability of the FLNG, when submerged in water.

It should be noted that the water level A in fig. 3a is indicated for a vessel where there is no LNG in the LNG storage tanks 13. When the tanks are loaded with LNG, the sponson structures 16 will normally be partially submerged in water and hence contribute to the buoyancy and hydrostatic stability mentioned above.

The device or FLNG 11 further comprises a LNG production system 17 for converting natural gas to LNG. The LNG production system 17 is arranged in the projecting hull structure 16. However, some elements of the LNG production system 17 may also be arranged in the ship hull 12, if suitable. It should be noted that the term "in" is used herein. However, a skilled person would know that the different elements of the LNG production system 17 may be located inside the hull structure 16, inside the ship hull 12, on the deck(s) of the hull structure 16 or the ship hull 12 etc or wherever it is suitable to provide such equipment.

The device or FLNG 11 further comprises means (not shown) for transferring LNG from the LNG production system 17 to the at least one spherical LNG storage tank 13. Moreover, the device 11 may also comprise means for receiving natural gas from an external source and means for processing and conveying the natural gas to the LNG production system 17.

Since the hull structure 16 does not substantially affect the ship hull 12, LNG storage tanks etc, the hull structure 16 and the LNG production system 17 are well suitable to be retrofitted onto the LNG carrier.

It is now referred to fig. 4, where the different elements of the LNG production system 17 are indicated with the following reference numbers:

- 5 - 17a – 17b denote compressor modules
- 17c denotes a gas pre-treatment module, for cleaning of the gas from the external source
- 17d denotes a pipe rack
- 10 - 17e denotes a liquefaction module for liquefying the gas
- 17f denotes a cooling module for cooling purposes
- 17g-17h denote yet a liquefaction module and cooling module respectively

These elements are considered well known for a skilled person, and will not be described further in detail here.

- 15 In the hull structure 16 there may also be provided void space(s), water ballast tank(s), or tank(s) for storage of hydrocarbon liquids etc. extracted by the LNG production system.

The sponson structures will now be described further in detail. The sponson structures are steel structures with stiffened shell plating and transverse
20 frames/bulkheads, designed so they can be welded directly to the sides of the ship hull 12, which has only a minor impact on the design of the ship hull 12. The sponson structures may be designed and manufactured by use of conventional ship structure elements like steel plates and rolled/built profiles etc.

The scantling of the sponson structures shall be satisfactory for supporting the
25 weights/loads from equipment installed on top of the sponsons, external sea pressures, internal tank liquid pressures etc. The sponson structures will also represent a significant increase of the overall longitudinal strength of the ship hull 12.

The top side of the sponson structures may be prepared as flat decks, which
30 provides space and structural strength for installation of equipment. This is the primary purpose of the sponsons, but equally important the sponsons will provide additional hydrostatic stability of the vessel, when the sponsons are submerged in water, which is an important aspect given the significant weight and centre of gravity of the equipment associated with the LNG production.

35 The main dimensions of the sponsons will depend on several factors, like required space for the equipment to be installed on top of the sponsons, required hydrostatic stability contribution from the sponsons, possible requirements for using the interior of the sponsons as liquid hydrocarbon storage and/or ballast water tanks etc.

It is noticeable that the invention is equally attractive for newbuilds and conversions, since the sponson installation only has minimum impact on the design of the ship hull 12 and no impact on the design of the LNG storage tank 3. Hence the invention represents an opportunity for utilizing already existing LNG carriers as FLNG units.

The sponsons may be erected and fitted to the ship hull structure in a building dock at a shipyard. However, the sponsons may also be designed and shaped in the way that they can be fitted when the ship hull is floating alongside an outfitting quay. The sponsons to be built in sections and lifted to final position by shore cranes or floating cranes. For simplification of the erection procedure the extension of the sponsons as far as possible is to be confined within the flat-of-side area of the main hull.

A method for converting an LNG-carrier to a device for floating production of LNG is also provided. As mentioned above, the LNG carrier is comprising a ship hull 12 and at least one spherical LNG storage tank 13 for storing LNG. The method comprises the following steps:

- providing the ship hull 12 of the LNG-carrier with a protruding hull structure 16;
- arranging an LNG production system 17 in the protruding hull structure 16;
- connecting the LNG production system 17 to the at least one spherical LNG storage tank 13.

The method may further comprise the step of fixing the hull structure 16 to the outer side surface of the ship hull 12.

The method may further comprise the step of welding the hull structure 16 to the ship hull 12.

The method may further comprise the step of retrofitting the hull structure 16 and the LNG production system 17 to the ship hull 12.

The method may further comprise the step of providing the hull structure 16 above the waterline of the ship hull 12.

Further modifications and variations will be obvious for a skilled man when reading the description above. The scope of the invention will appear from the following claims and their equivalents.

CLAIMS

1. Device for floating production of LNG, comprising:

- a LNG carrier comprising a ship hull and at least one spherical LNG storage tank for storing LNG;

5 - a projecting hull structure fixed to the ship hull;

- a LNG production system for converting natural gas to LNG, where the LNG production system is arranged in the projecting hull structure;

- means for transferring LNG from the LNG production system to the at least one spherical LNG storage tank.

10 2. Device according to claim 1, wherein some elements of the LNG production system is arranged in the ship hull.

3. Device according to claim 1, wherein the hull structure is fixed to the outer side surface of the hull of the LNG carrier.

15 4. Device according to claim 1, where the ship hull and the hull structure is an integral structure.

5. Device according to claim 1, wherein the hull structure is welded to the ship hull.

6. Device according to claim 1, wherein an upper surface of the hull structure is substantially level with the main deck of the LNG-carrier.

20 7. Device according to claim 1, wherein the hull structure is arranged above the water level of the ship hull.

8. Device according to claim 1, wherein it comprises means for receiving natural gas from an external source and means for conveying the natural gas to the LNG production system.

9. Device according to claim 1, wherein the hull structure is watertight.

25 10. Device according to claim 1, wherein the hull structure comprises buoyancy compartments.

11. Device according to claim 1, wherein the hull structure and the LNG production system are provided to be retrofitted to the LNG carrier.

30 12. Method for converting an LNG-carrier to a device for floating production of LNG, where the LNG carrier is comprising a ship hull and at least one spherical LNG storage tank for storing LNG, wherein the method comprises the following steps:

- providing the ship hull of the LNG-carrier with a protruding hull structure;

- arranging an LNG production system in the protruding hull structure;
- connecting the LNG production system to the at least one spherical LNG storage tank.

5 13. Method according to claim 12, wherein the method comprises fixing the hull structure to the outer side surface of the ship hull.

14. Method according to claim 12, wherein the method comprises welding the hull structure to the ship hull.

15. Method according to claim 12, wherein the method comprises retrofitting the hull structure and the LNG production system to the ship hull.

10 16. Method according to claim 12, wherein the method comprises providing the hull structure above the waterline of the ship hull.