

## DESCRIPTION

### FLOATING FACILITY

Technical Field

[0001]

The present invention relates to a floating facility including a liquefied natural gas plant.

Background Art

[0002]

As a facility that liquefies natural gas (NG) produced from gas fields, a floating facility called floating LNG (FLNG) is known in which a floating body such as a hull is disposed on the sea, and a plant (liquefied natural gas plant, hereinafter also referred to as "LNG plant") that liquefies NG is disposed on the floating body.

[0003]

The FLNG is a huge structure that has a total length of several hundred meters and is built over a period of one year or more. In particular, an LNG plant constituted by a combination of a large number of devices is disposed on the floating body, while a plurality of LNG tanks is disposed in the floating body. For this reason, it is one of points to shorten a construction period of the FLNG to install the LNG plant on the floating body as soon as possible after the LNG tanks are constructed in the floating body.

[0004]

For example, Patent Literature 1 describes a technique for constructing a tank area in which LNG is stored and a factory area including a natural gas liquefaction plant as separate floating structures, and then connecting these floating structures to each other in a length direction.

Meanwhile, Patent Literature 1 does not describe any suitable configuration for constructing a floating structure in which a natural gas liquefaction plant is disposed on the tank area.

#### Citation List

Patent Literature

[0005]

Patent Literature 1: JP 2015-13494 A

#### Summary of Invention

Technical Problem

[0006]

The present invention has been achieved under such a background, and provides a technique for efficiently constructing a floating facility including a liquefied natural gas plant.

Solution to Problem

[0007]

A floating facility of the present invention includes:

a floating body disposed on the sea and having a planar shape that is longer in a ship length direction than in a ship width direction;

a liquefied natural gas plant disposed on the floating body; and

a plurality of liquefied natural gas tanks formed in the floating body, in which

the plurality of liquefied natural gas tanks includes a single arrangement portion in which the liquefied natural gas tanks are arranged in one row in the ship length direction of the floating body,

on an upper surface side of the floating body in which the liquefied natural gas tanks constituting the single arrangement portion are formed, tank domes serving as pull-out positions where pipes connected to the liquefied natural gas tanks are pulled out from the upper surface side are arranged in the ship length direction,

devices constituting the liquefied natural gas plant are arranged in a plant disposition area formed separately from the area where the tank domes are arranged in the ship length direction, and

above the arrangement of the tank domes, a pipe support frame portion stacking and holding a plant pipe group through which a fluid handled by the liquefied natural gas plant flows, a tank pipe group through which a fluid flowing in and out of the liquefied natural gas tanks flows, and a joint portion between the pipes pulled out via the tank domes and the tank pipe group is disposed in the ship length direction.

[0008]

The floating facility may have the following characteristics.

(a) In the plant disposition area, devices constituting the liquefied natural gas plant are individually disposed on a deck of the floating body.

(b) Between the pipe support frame portion and the plant disposition area, an occupant passing passage and/or a passage for transporting devices constituting the liquefied natural gas plant are/is formed.

(c) A plurality of liquefied natural gas tanks not included in the single arrangement portion are included, and these liquefied natural gas tanks are formed by dividing the inside of the floating body into a plurality of parts in the ship width direction.

Advantageous Effects of Invention

[0009]

According to the present invention, above the tank domes to be installed finally in a process of constructing the liquefied natural gas tanks in the floating body, a pipe support frame portion stacking and holding a tank pipe group through which a fluid flowing in and out of the liquefied natural gas tanks flows, a joint portion between pipes pulled out via the tank domes and the tank pipe group, and the like is disposed. By disposing the plant disposition area at a position separated from the pipe support frame portion, it is possible to start construction of the liquefied natural gas plant without waiting for completion of the tank domes, the joint portion, and the like.

#### Brief Description of Drawings

[0010]

Fig. 1 is a schematic diagram of an FLNG in prior art.

Fig. 2 is a cross-sectional view of the FLNG in prior art.

Fig. 3 is a schematic diagram of an FLNG according to an embodiment.

Fig. 4 is a cross-sectional view of the FLNG according to the embodiment.

Fig. 5 is a cross-sectional view of an FLNG according to a second embodiment.

Fig. 6 is a cross-sectional view of an FLNG according to a third embodiment.

Fig. 7 is a plan view of an FLNG according to a fourth embodiment.

Fig. 8 is a plan view illustrating a modification of the FLNG according to any one of the embodiments.

Fig. 9 is a schematic diagram relating to a variation of a method for installing a loading arm on a floating body.

#### Description of Embodiments

[0011]

First, the configuration of an FLNG 1a in prior art will be described with reference to Fig. 1.

In the FLNG 1a, a turret 12, which is a mooring facility, is disposed on a bow side of a hull 10, which is a floating body disposed on the sea. The turret 12 is connected to a mooring line to moor the hull 10, and is connected to a riser that transports mined natural gas (NG) underwater (the mooring line and the riser are not illustrated). Hereinafter, description will be made by defining the direction in which the turret 12 is disposed as a front of the hull 10.

For example, at a position closer to the left side on the bow side on a main body of the hull 10, a flare stack 14 for combustion of excess gas generated in an LNG plant 2 or an LNG tank 11 is disposed.

[0012]

As illustrated in Fig. 1(b), when the hull 10 is viewed from an upper surface side, a pipe rack 22 is disposed in a central area in a ship width direction so as to extend in a length direction of the hull 10. The pipe rack 22 is a frame structure holding a plurality of plant pipes 221 (plant pipe group) through which various fluids handled in the LNG plant 2 flow.

[0013]

Areas adjacent to both left and right sides of the pipe rack 22 are plant disposition areas 20 in which devices constituting the LNG plant 2 are disposed (Fig. 1(c)). In each of these plant disposition areas 20, a plurality of modules 21 constituting the LNG plant 2 is arranged in a front-rear direction.

For example, the module 21 is a division unit in which a device group constituting a process unit that performs various processes for NG is incorporated in a common frame. In each of the modules 21, a large number of devices constituting the LNG plant 2, for example, a static device such as a tower tank or a heat exchanger, a dynamic

device such as a pump, a connection pipe connecting a static device to a dynamic device, and a connection pipe used for connection to pipes on the pipe rack 22 side are disposed.

[0014]

These modules 21 are disposed at a position above tank domes 110, which will be described later, via column bases 211 disposed on a deck of the hull 10.

Note that it is not an essential requirement to dispose various device groups in the frame to constitute the module 21. For example, the module 21 may be constituted by disposing these device groups on a pallet-shaped base.

[0015]

Examples of the process unit constituting the LNG plant 2 include a gas-liquid separation unit that separates liquid contained in NG received from the riser, a pretreatment unit that removes acidic gas (carbon dioxide, hydrogen sulfide, or the like), moisture, and mercury, a distillation separation unit that performs distillation separation of NG from which impurities have been removed to obtain methane, and a liquefaction unit that liquefies methane.

Furthermore, a living unit 13 is disposed at a position rearward from the area where the modules 21 and

the pipe rack 22 are disposed.

[0016]

As illustrated in Figs. 1(a), 1(c), and 2, a plurality of LNG tanks 11 is formed in the main body of the hull 10. For example, the LNG tanks 11 are formed of membrane type tanks.

In this FLNG 1a, the plurality of LNG tanks 11 is disposed by dividing the hull 10 into a plurality of parts in the ship width direction from a viewpoint of suppressing occurrence of sloshing and efficiently using a space in the hull 10. Furthermore, by arranging a plurality of sets of these LNG tanks 11 arranged in the ship width direction, a plurality of rows of LNG tanks 11 is arranged when viewed in the ship length direction. As illustrated in Fig. 1(c), this FLNG 1a includes two rows each including four LNG tanks 11.

[0017]

Fig. 2 is a vertical front view of the FLNG 1a viewed from the position of A-A' in Fig. 1(c). As illustrated in Fig. 2, the tank dome 110 is installed on an upper surface side of each of the LNG tanks 11. The tank dome 110 serves as a pull-out position where various pipes connected to the LNG tank 11 (a loading pipe, an offloading pipe, a rundown pipe, a vapor pipe, and the like) are pulled out to an upper surface side of the hull 10. For

example, the tank dome 110 is disposed at a position penetrating a ceiling of the LNG tank 11 main body, and includes, for example, a cylindrical or square dome main body to which these pipes are attached and opening/closing valves for the pipes.

[0018]

For convenience of illustration, Fig. 2 illustrates a state in which only one offloading pipe 152 that discharges LNG in each of the LNG tanks 11 using an LNG pump 151 is connected to the tank dome 110. Actually, as described above, a large number of pipes are pulled out to the upper surface side of the hull 10 via the tank dome 110.

Note that the modules 21 constituting the LNG plant 2 are supported on a high floor via the column bases 211 disposed on the deck of the hull 10 to avoid interference with the tank domes 110.

[0019]

A pipe pulled out to the upper surface side of the hull 10 via the tank dome 110 is connected to various main pipes. For example, the offloading pipe 152 is connected to an offloading main pipe connected to a loading arm 41 that discharges LNG toward an LNG transport ship 5. A rundown pipe is connected to a rundown main pipe that allows LNG liquefied in a liquefaction unit of the LNG

plant 2 to flow into each of the LNG tanks 11.

Hereinafter, a pipe through which a fluid flowing in and out of the LNG tank 11, such as the offloading main pipe or the rundown main pipe is referred to as a tank pipe 222.

[0020]

Various pipes pulled out via the tank dome 110 are connected to the tank pipes 222 via branch pipes. As described above, the tank dome 110 includes a large number of pipes, and these pipes are connected to the tank pipes 222, respectively. Therefore, the circumference of the actual tank dome 110 is in a state in which a large number of branch pipes are intricately disposed so as not to interfere with each other. An area where the branch pipes are disposed is referred to as a joint portion 111.

[0021]

As illustrated in Fig. 2, the tank pipes 222 connected to pipes on the tank dome 110 side via the joint portion 111 are disposed on a lower side of the pipe rack 22. In the pipe rack 22, a space between a lower side area where the tank pipes 222 are disposed and an upper side shelf where the plant pipes 221 are held is a passage 223 through which an occupant passes.

[0022]

Problems in constructing the FLNG 1a having the schematic configuration described above in prior art will

be described.

When the LNG tanks 11 are constructed in the hull 10, the tank dome 110 described above is a device installed in a final step of the construction. After the tank dome 110 is installed, intricate pipe installation work for connecting the tank pipes 222 to a large number of branch pipes is performed at the joint portion 111.

[0023]

Meanwhile, in the FLNG 1a in which the plurality of rows of LNG tanks 11 is arranged in the ship length direction of the hull 10 in prior art, as illustrated in Fig. 1(c), there is a high possibility that the tank domes 110 may be located below the modules 21. For this reason, there is a restriction that it is necessary to wait for the installation work of the tank domes 110 and the joint portion 111, and therefore a construction period of the FLNG 1a is shortened by installing the modules 21 on the hull 10.

Meanwhile, when the LNG plant 2 is constructed by a stick-built method described later, there is a restriction that installation of a large-scale plant device 23 cannot be started because there is a restriction that it is necessary to wait for the installation work.

[0024]

In order to solve the above-described problems, an

FLNG 1 according to the following embodiment has a structure in which the installation of the tank domes 110 and the joint portion 111 and the construction of the LNG plant 2 can be performed independently. Hereinafter, the configuration of the FLNG 1 will be described with reference to Figs. 3 and 4. Fig. 4 is a vertical front view of the FLNG 1 viewed from the position of B-B' in Fig. 3(c). Note that in each of FLNGs 1 and 1b to 1g described below with reference to Figs. 3 to 9, components common to the FLNG 1a described above are designated by the same reference numerals as those used in Fig. 1, and repeated description thereof will be omitted.

[0025]

First, in the FLNG 1 illustrated in Figs. 3 and 4, an LNG plant 2 in which plant devices (devices constituting LNG plant 2) 23 are individually disposed on a deck of a hull 10 and which is constructed by a so-called stick-built method is disposed. As compared with a method for constructing the LNG plant 2 with the modules 21, the stick-built method can reduce cost of the frame constituting the modules 21.

[0026]

As illustrated in Figs. 3(c) and 4, in the FLNG 1 of this example, a plurality of LNG tanks 11 formed in the hull 10 is arranged in one row in the ship length direction

of the hull 10 and constitutes a single arrangement portion. In this case, the tank width of each of the LNG tanks 11 is set to a dimension within a range that does not cause sloshing.

[0027]

Furthermore, for example, in a central area in front of the hull in the ship width direction, tank domes 110 of the hull 10 are arranged in the ship length direction. By arranging the tank domes 110 in the central area, LNG in the LNG tanks 11 can be evenly extracted.

[0028]

In the FLNG 1 of this example, above the arrangement of the tank domes 110, a pipe support frame portion 3 stacking and holding the joint portion 111, the plurality of tank pipes 222 (tank pipe group), and the plurality of plant pipes 221 (plant pipe group) is disposed. For example, the pipe support frame portion 3 is an elongated shelf-shaped frame structure extending in the ship length direction of the hull 10, in which a tank dome stage 31, a joint portion stage 32, a tank pipe support stage 33, and a plant pipe support stage 34 are disposed in this order from a lower layer side.

[0029]

As illustrated in Figs. 3(b), 3(c), and 4, in an area on the deck of the hull 10 located on both left and

right sides of the pipe support frame portion 3, the plant disposition area 20 is disposed separately from the area where the pipe support frame portion 3 is disposed (that is, the area where the plurality of tank domes 110 is arranged in the ship length direction of the hull 10). The plant devices 23 constituting the LNG plant 2 are disposed in the plant disposition area 20.

Here, the pipe support frame portion 3 of this example does not have the passage 223 formed in the pipe rack 22 of the FLNG 1a in prior art. Therefore, a passage 16 may be formed between the pipe support frame portion 3 and the plant disposition area 20. The passage 16 is formed so as to be used as at least one of an occupant passing passage and a passage for transporting the plant devices 23 constituting the LNG plant 2.

[0030]

The FLNG 1 of this example has the following effects. Above the tank domes 110 to be installed finally in a process of constructing the LNG tanks 11 in the hull 10, the pipe support frame portion 3 stacking and holding the plant pipe 221, the tank pipe 222, and the joint portion 111 is disposed (Figs. 3(c) and 4). By disposing the plant disposition area 20 at a position separated from the pipe support frame portion 3, it is possible to start construction of the LNG plant 2 without waiting for

completion of the tank domes 110, the joint portion 111, and the like.

For example, the pipe support frame portion 3 can be installed by stacking each stage at an appropriate time according to progress of construction of the tank domes 110, the joint portion 111, and the LNG plant 2.

[0031]

Here, the position where the pipe support frame portion 3 is disposed is not limited to the central area of the hull 10 in the ship width direction. When there is no problem in extracting LNG, the pipe support frame portion 3 may be disposed not in the central area but on a ship side as in an FLNG 1b illustrated in Fig. 5. In the example illustrated in Fig. 5, the plant disposition area 20 is disposed also on the left side of the pipe support frame portion 3 toward the bow side. However, the plant disposition area 20 may be disposed only on one side (for example, the right side) of the pipe support frame portion 3.

It is not essential to form the passages 16 on both sides of the pipe support frame portion 3 as illustrated in Fig. 4. In this regard, Fig. 5 also illustrates an example in which the passage 16 is formed only between the pipe support frame portion 3 and the plant disposition area 20 disposed on one side of the pipe support frame portion 3.

In addition, a passage for transporting the plant devices 23 may be formed between the pipe support frame portion 3 and the plant disposition area 20 disposed on the other side of the pipe support frame portion 3. Furthermore, the passage 16 and the passage for transporting the plant devices 23 may be used together.

[0032]

The LNG plant 2 disposed in the plant disposition area 20 is not limited to one constructed by the stick-built method. As illustrated in an FLNG 1c of Fig. 6, the modules 21 may be disposed in the plant disposition area 20 to construct the LNG plant 2. The module 21 may have devices of the LNG plant 2 disposed in a frame, or may have these devices disposed on a pallet-shaped base.

[0033]

When the plurality of LNG tanks 11 is disposed in the hull 10, the hull 10 may include an arrangement portion other than the one-row arrangement (single arrangement portion). For example, an FLNG 1d illustrated in Fig. 7 includes, in addition to the single arrangement portion in which the LNG tanks 11 are arranged in one row, the LNG tanks 11 formed by dividing the inside of the hull 10 into a plurality of rows (two rows in this example) in the ship width direction.

[0034]

On an upper surface side of the LNG tanks 11 formed by dividing the inside of the hull 10 into the plurality of rows, for example, the modules 21 or the individual plant devices 23 may be installed at positions other than the installation positions of the tank domes 110. Fig. 7 illustrates an example in which the modules 21 are disposed at positions deviated from the tank domes 110 on the upper surface side of the LNG tanks 11 arranged in two rows. In this case, an installation area of branch pipes extending from the installation positions of the tank domes 110 to the tank pipe support stage 33 of the pipe support frame portion 3 serves as the joint portion 111.

[0035]

Note that the FLNG 1 illustrated in Fig. 3(c) illustrates an example in which the plurality of tank domes 110 is arranged so as to be arranged substantially in a straight line in an area below the pipe support frame portion 3 (an area where the tank domes 110 are arranged). On the contrary, as illustrated in an FLNG 1e in Fig. 8, for the purpose of avoiding a restriction on layout of the branch pipes in the joint portion 111 and interference with other devices, these tank domes 110 may be arranged at positions deviated from each other when viewed in the ship width direction of the hull 10.

In this case as well, it can be said that the

plurality of tank domes 110 is arranged in the area below the pipe support frame portion 3 in the ship length direction of the hull 10.

[0036]

Fig. 9 is a configuration example for preventing the loading arm 41 disposed on an FLNG 1f side or an FLNG 1g side from becoming difficult to reach the LNG transport ship 5 as the hull becomes larger.

The FLNG 1f illustrated in Fig. 9(a) illustrates an example in which an arm support 42 projecting laterally from the bottom of the hull 10 is disposed and the loading arm 41 is disposed on the arm support 42. The FLNG 1g illustrated in Fig. 9(b) illustrates an example in which a deck on a ship side of the hull is cut out to form a recess 43, and the loading arm 41 is disposed in the recess 43.

#### Reference Signs List

[0037]

|             |                 |
|-------------|-----------------|
| 1, 1a to 1g | FLNG            |
| 10          | Hull            |
| 11          | LNG tank        |
| 110         | Tank dome       |
| 111         | Joint portion   |
| 152         | Offloading pipe |
| 16          | Passage         |

|     |                            |
|-----|----------------------------|
| 2   | LNG plant                  |
| 20  | Plant disposition area     |
| 21  | Module                     |
| 221 | Plant pipe                 |
| 222 | Tank pipe                  |
| 23  | Plant device               |
| 3   | Pipe support frame portion |

## CLAIMS

1. A floating facility comprising:

a floating body disposed on the sea and having a planar shape that is longer in a ship length direction than in a ship width direction;

a liquefied natural gas plant disposed on the floating body; and

a plurality of liquefied natural gas tanks formed in the floating body, wherein

the plurality of liquefied natural gas tanks includes a single arrangement portion in which the liquefied natural gas tanks are arranged in one row in the ship length direction of the floating body,

on an upper surface side of the floating body in which the liquefied natural gas tanks constituting the single arrangement portion are formed, tank domes serving as pull-out positions where pipes connected to the liquefied natural gas tanks are pulled out from the upper surface side are arranged in the ship length direction,

devices constituting the liquefied natural gas plant are arranged in a plant disposition area formed separately from the area where the tank domes are arranged in the ship length direction,

above the arrangement of the tank domes, a pipe support frame portion stacking and holding a plant pipe

group through which a fluid handled by the liquefied natural gas plant flows, a tank pipe group through which a fluid flowing in and out of the liquefied natural gas tanks flows, and a joint portion between the pipes pulled out via the tank domes and the tank pipe group is disposed in the ship length direction, and

the pipe support frame portion is provided with a joint portion stage supporting the joint portion, a tank pipe support stage supporting the tank pipe group, and a plant pipe support stage supporting the plant pipe group, in this order from a lower layer side.

2. The floating facility according to claim 1, wherein in the plant disposition area, devices constituting the liquefied natural gas plant are individually disposed on a deck of the floating body.

3. The floating facility according to claim 1, wherein between the pipe support frame portion and the plant disposition area, an occupant passing passage and/or a passage for transporting devices constituting the liquefied natural gas plant are/is formed.

4. The floating facility according to claim 1, comprising a plurality of liquefied natural gas tanks not included in the single arrangement portion, wherein these liquefied natural gas tanks are formed by dividing an inside of the floating body into a plurality of parts in the ship width direction.