

DESCRIPTION

FLOATING STRUCTURE

Technical Field

[0001] The present invention relates to a floating structure to which tanks mounted on an existing LNG cargo ship or floating structure were transferred.

Background Art

[0002] Conventionally, it has been known that LNG tanks, which carry non-corrosive liquefied natural gas, do not easily suffer from aging. Focusing on such properties of LNG tanks, a technique has been proposed in which LNG tanks on an aged LNG cargo ship are transferred to construct a new floating structure (see, for example, Patent Literature 1). According to this technology, LNG tanks, which require a long time to manufacture, can be reused as tanks for storing liquefied natural gas, so that the construction process of a newly built floating structure can be significantly shortened.

Citation List

Patent Literature

[0003] Patent Literature 1: JP 2012-86768 A

Summary of Invention

Technical Problem

[0004] In the above-mentioned technique, it is also possible to further position natural gas processing equipment in a new floating structure. In this case, as illustrated in (a) and (b) of FIG. 2, it is conceivable to position the natural gas processing equipment 108 closer to the bow side.

However, such positioning involves a problem in that the positioning space for LNG tanks 106 is small and affects the number of the LNG tanks 106.

[0005] Furthermore, when the LNG tanks 106 are positioned in the center of the hull structure 104, it is difficult to ensure the positioning space for the natural gas processing equipment 108 on the broadsides. To address this, it is conceivable to add an overhang in the width direction of the broadsides and position the natural gas processing equipment 108 on the overhang. However, in this case, a new problem arises in that the floating structure 102 becomes large.

[0006] An object of the present invention is to provide a slim floating structure in which natural gas processing equipment is positioned while ensuring a positioning space for tanks.

Solution to Problem

[0007] A floating structure according to the present invention includes:

tanks transferred from an existing LNG cargo ship or an existing floating structure, and positioned continuously in a lengthwise direction of a hull structure; and

a natural gas processing equipment positioned on at least one side among both sides of the tanks in a width direction of the hull structure, wherein

the natural gas processing equipment is positioned on an inside in the width direction of the hull structure.

[0008] In the floating structure according to the present invention,

the natural gas processing equipment is positioned on both sides of the tanks.

[0009] In the floating structure according to the present invention,

the natural gas processing equipment is positioned along a starboard side of the hull structure and a port side of the hull structure.

[0010] In the floating structure according to the present invention,

the natural gas processing equipment includes a pretreatment equipment for pretreating natural gas and a liquefaction equipment for liquefying natural gas,

wherein the pretreatment equipment is positioned at an end of the hull structure in the lengthwise direction, and

the liquefaction equipment is positioned on the inside in the width direction of the hull structure.

[0011] In the floating structure according to the present invention,

the natural gas processing equipment includes a pretreatment equipment for pretreating natural gas and a liquefaction equipment for liquefying natural gas,

wherein the liquefaction equipment is positioned on the inside in the width direction of the hull structure and is provided in two lines, and

one line of the liquefaction equipment is positioned on a starboard side of the hull structure, and another line of the liquefaction equipment is positioned on a port side of the hull structure.

[0012] In the floating structure according to the present invention,

the liquefaction equipment and the tanks are connected through pipes for feeding liquefied natural gas liquefied by the liquefaction equipment to the tanks.

[0013] In the floating structure according to the present invention,

the tanks include six or more tanks continuously positioned in the lengthwise direction of the hull structure.

[0014] In the floating structure according to the present invention,

the tanks are spherical tanks.

Advantageous Effects of Invention

[0015] According to the present invention, a slim floating structure can be provided in which natural gas processing equipment is positioned while ensuring a positioning space for LNG tanks that store liquefied natural gas.

Brief Description of Drawings

[0016] FIG. 1 is a schematic view of a floating structure according to an embodiment.

FIG. 2 is a schematic view of a conventional floating structure.

Description of Embodiments

[0017] Hereinafter, a floating structure according to an embodiment of the present invention will be described with reference to the drawings. (a) of FIG. 1 is a schematic view of a floating structure 2 according to the embodiment viewed from above, and (b) of FIG. 1 is a schematic view of the floating structure 2 viewed from a side (starboard side). As illustrated in (a) and (b) of FIG. 1, the floating structure 2 is a marine structure having a hull structure 4 serving as a main body. In the floating structure 2 according to the embodiment, six tanks 6 are continuously positioned in a row in a central lengthwise direction of the hull structure 4. Horizontal partition walls (not illustrated) across both sides are appropriately positioned between adjacent tanks 6. In addition, natural gas processing equipment 8, a residential area 10, a laydown area 12, and a power unit 14 are positioned on the floating structure 2. The “hull structure” according to the present embodiment means a structure the outer edges of which are defined as one structure at the time of construction, and is a concept that does not include structures additionally joined (hereinafter, also referred to as overhangs) for the purpose of expanding the structure after construction.

[0018] The floating structure 2 is used as an offshore plant. Known examples of such equipment include such systems as a floating production, storage, and offloading system (FPSO) that produces, stores, and offloads oil, natural gas, or the like, a floating storage and offloading system (FSO) that does not include a production system and only performs storage and offloading, or a floating storage unit (FSU) that only performs storage. Furthermore, as one of the FPSOs, a floating liquefied natural gas production system (FLNG) that is specialized in production, storage, and offloading of liquefied natural gas (LNG) is known. In the embodiment of the present invention, a case where the floating structure 2 is an FLNG will be described as an example.

The floating structure 2 has no self-propelled function, and when it moves, it is towed by a power vessel.

[0019] The hull structure 4 is a unidirectionally long structure having a lengthwise direction and a lateral direction. The hull structure 4 is called a hull, and the hull structure having a double structure is called a double hull. In the floating structure 2 according to the embodiment, the hull structure 4 is newly constructed. It is assumed that the total length of the hull structure 4 in the present embodiment is 350 m to 450 m, but the total length of the hull structure 4 may be longer or shorter than this.

[0020] The tanks 6 are spherical tanks made of an aluminum alloy having a diameter of about 25 m to 60 m, and store liquefied natural gas cooled to minus 162°C. Specifically, liquefaction equipment 8b, which will be described later, and the tanks 6 are connected through pipes (not illustrated). The liquefied natural gas liquefied in the liquefaction equipment 8b is fed to the tanks 6 via the pipes and stored in the tanks 6. Such spherical tanks 6 are called Moss-type spherical tanks. The upper part of each tank 6 protrudes from the hull structure 4 and is covered with a steel tank cover (not illustrated). The lower part of each tank 6 is housed inside the hull structure 4. These tanks 6 were transferred from an existing LNG cargo ship, and are continuously positioned so that their centers are lined up in a row in the lengthwise direction of the hull structure 4. The Moss-type spherical tanks of the existing floating structure comparatively do not suffer from aging and are in a sufficiently usable state, so that low-cost and durable tanks can be reused.

[0021] The natural gas processing equipment 8 includes pretreatment equipment 8a, heavy component removal equipment (not illustrated), and the liquefaction equipment 8b. The pretreatment equipment 8a is equipment for performing pre-stage steps of liquefying raw material natural gas supplied from a well site, and is positioned on the bow side of the hull structure 4. This pretreatment equipment 8a performs the process up to a separation step of separating condensate contained in the raw material natural gas, an acid gas removal step of removing acid

gas, a mercury removal step of removing mercury, and a dewatering step of performing dewatering treatment.

[0022] Here, the condensate separated in the separation step is stored in a condensate tank (not illustrated). In the acid gas removal step, amines are brought into countercurrent contact with the raw material natural gas in an absorption tower (not illustrated), and environmental pollutants such as carbon dioxide gas and hydrogen sulfide are absorbed by the amines and removed.

[0023] The mercury removal step is a step of removing mercury from the raw material natural gas when the raw material natural gas contains a small amount of mercury vapor. Mercury corrodes aluminum alloys used as low-temperature members and need to be removed. In the dewatering step, water is removed from the raw material natural gas from which impurities have been removed, by using an adsorbent. This dewatering is performed to prevent ice from being generated in a subsequent liquefaction step and freezing the pipes.

[0024] Since the composition of raw material natural gas differs from one well site to another, the amount of objects to be removed contained in the raw material natural gas, which should be removed by the pretreatment equipment 8a, also differs from one well site to another. That is, since the type and size of devices positioned in the pretreatment equipment 8a are designed according to the properties of the raw material natural gas from the well site, the types and sizes of the devices can vary depending on which well site the natural gas to be processed is from.

[0025] For example, if the raw material natural gas from a well site contains a larger amount of CO₂ and mercury than usual, the required capacity of the devices that perform the acid gas removal step and the mercury removal step increases. For this reason, the pretreatment equipment 8a is preferably positioned in a relatively large space such as the bow side where the tanks 6 are not positioned, so that the positioning space can be flexibly designed by increasing or decreasing the positioning space according to the types and sizes of the devices. In addition, positioning the pretreatment equipment 8a on the bow side allows adaptation to a design change if any, which would occur due to a change in the composition of the raw material natural gas, by adjusting the

length of the hull structure 4 in the lengthwise direction. The impact of the design change of the pretreatment equipment 8a on the design of the entire hull structure is thus kept small.

[0026] The heavy component removal equipment performs a heavy component removal step of removing heavy components from the raw material natural gas. The heavy component removal equipment is a part that separates the natural gas treated by the pretreatment equipment 8a into fractions such as methane, ethane, and propane. In the heavy component removal equipment, in addition to separation of methane, heavy hydrocarbons such as ethane, propane, and butane are separated and recovered. The heavy component removal equipment may be positioned on the bow adjacent to the pretreatment equipment 8a, or may be positioned on a side of the tanks 6 in the width direction of the hull structure 4. Furthermore, among the devices installed in the heavy component removal equipment, some devices may be positioned on the bow side, and the other devices may be positioned on a side of the tanks 6.

[0027] The liquefaction equipment 8b is equipment for performing a step of liquefying the raw material natural gas, and is positioned on both sides of the tanks 6 in the width direction of the hull structure 4. The liquefaction equipment 8b is provided in two lines. One line of the liquefaction equipment 8b is positioned on the starboard side of the hull structure 4 along the lengthwise direction, and the other line of the liquefaction equipment 8b is positioned on the port side of the hull structure 4 along the lengthwise direction. In the present embodiment, the liquefaction equipment 8b is provided in two lines for one pretreatment equipment 8a. In the present embodiment, the starboard side liquefaction equipment 8b and the port side liquefaction equipment 8b are located at the same position in the lengthwise direction of the hull structure 4 (overlap in the width direction of the hull structure 4) and face each other with the tanks 6 interposed therebetween.

[0028] Furthermore, the liquefaction equipment 8b is positioned on the inside in the width direction of the hull structure 4 so as not to protrude from the hull structure 4. Thus, it is not necessary to add any overhang in the width direction in order to ensure the positioning space on

the broadsides, and the slim hull structure 4 can be designed. Furthermore, in the liquefaction equipment 8b, a heat exchanger for liquefying methane separated by a demethanizer tower (not illustrated), a refrigerant circuit supplying a refrigerant to the heat exchanger, and the like are provided. According to the present embodiment, the devices (heat exchanger and refrigerant circuit) are designed to be equal-sized in the two lines of the liquefaction equipment 8b, so that the same amount of liquefied natural gas can be produced.

[0029] This liquefaction equipment 8b performs a liquefaction step of liquefying the raw material natural gas. Specifically, the liquefaction equipment 8b is a part that liquefies the methane separated by the demethanizer tower in the heavy component removal device. In the liquefaction step, the raw material natural gas sent to the heat exchanger is heat-exchanged with low-temperature gas supplied from the refrigerant circuit, cooled to minus 162°C or less, and thus liquefied. The liquefied low-temperature raw material natural gas is fed to the tanks 6 via the pipes and stored in the tanks 6.

[0030] Here, since the liquefaction equipment 8b is equipment that handles the raw material natural gas treated by the pretreatment equipment 8a, once the production amount of the raw material natural gas is determined, the layout such as the sizes of devices and the installation positions of the devices is determined in an early stage. That is, the liquefaction equipment 8b is equipment with few variation factors. Therefore, it is possible to design the liquefaction equipment 8b in an early stage such that the liquefaction equipment 8b has an elongated shape extending in one direction along the lengthwise direction of the hull structure 4. By performing such a design in advance, as illustrated in FIG. 1, the liquefaction equipment 8b can be designed to achieve space saving on the sides of the tanks 6 along the starboard side and port side of the hull structure 4.

[0031] The residential area 10 is a facility equipped with crew rooms, a kitchen, and the like. The laydown area 12 is an area where target devices and the like are temporarily placed during maintenance. The power unit 14 is equipment provided with a generator for operating the natural

gas processing equipment 8. The residential area 10, the laydown area 12, and the power unit 14 are positioned together on the stern side.

[0032] The invention according to the present embodiment can provide a slim floating structure in which the natural gas processing equipment 8 is positioned while ensuring the positioning space for the tanks 6 by designing in advance the liquefaction equipment 8b with few layout variation factors into an elongated shape extending in one direction along the lengthwise direction of the hull structure 4 and positioning the liquefaction equipment 8b on both sides of the tanks 6.

[0033] In addition, since the liquefaction equipment 8b has few layout variation factors, the liquefaction equipment 8b is designed in advance into an elongated shape corresponding to the space on the sides of the tanks 6 in the width direction of the hull structure 4, so that it is possible to make the floating structure 2 in which the length of the hull structure 4 in the width direction is suppressed while effectively utilizing the space on both sides of the tanks 6.

[0034] Furthermore, by positioning the natural gas processing equipment 8 along the starboard side and port side of the hull structure, the dead space on the hull structure 4 can be effectively utilized. If six or more tanks 6 are positioned in the lengthwise direction of the hull structure 4, a sufficient space for positioning the liquefaction equipment 8b is ensured, so that the design of the liquefaction equipment 8b can be established in an early stage. Furthermore, since the positioning space for the natural gas processing equipment 8 does not overlap with the positioning space for the tanks 6, it is not necessary to reduce the number of the tanks 6. Positioning the liquefaction equipment 8b on the inside in the width direction of the hull structure 4 eliminates the need for adding any overhang for ensuring the space for positioning the liquefaction equipment 8b on the broadsides.

[0035] Positioning the pretreatment equipment 8a intensively on the bow side and positioning the liquefaction equipment 8b on both sides of the tanks 6 can allow the length (X) from the tank 6 located closest to the bow side to the stern of the hull structure 4 to be determined in an early stage and allow the length (Y) from the bow to this tank 6 to be changed. Therefore, the design

and construction period of the floating structure 2 can be shortened, and the design change of the pretreatment equipment 8a can be flexibly adapted.

[0036] The liquefaction equipment 8b is provided in two lines for one pretreatment equipment 8a, so that even if one line of the liquefaction equipment 8b goes down and fails to produce natural gas, production of natural gas can be continued with the other line of the liquefaction equipment 8b.

[0037] The liquefaction equipment 8b is provided in two lines for one pretreatment equipment 8a and the two lines of the liquefaction equipment 8b are positioned with the tanks 6 interposed therebetween, so that It is no longer necessary to connect the liquefaction equipment 8b positioned on the starboard side of the hull structure 4 and the liquefaction equipment 8b located on the port side of the hull structure 4 through pipes. That is, the liquefaction equipment 8b is equipment that performs the final-stage process of the natural gas processing equipment 8, and the liquefied natural gas is discharged to the tanks 6 as a product. Therefore, there is no transfer of fluid between the starboard side liquefaction equipment 8b and the port side liquefaction equipment 8b without the need for connecting them through pipes, which eliminates the need for laying pipes in the area where the tanks 6 are installed. The number of pipes positioned in the natural gas processing equipment 8 can thus be significantly reduced, and the pipe design is facilitated.

[0038] In the present embodiment, the starboard side liquefaction equipment 8b and the port side liquefaction equipment 8b are located at the same position in the lengthwise direction of the hull structure 4 (overlap in the width direction of the hull structure 4) and face each other with the tanks 6 interposed therebetween. Therefore, since the sizes and positions of the areas where the equipment other than the liquefaction equipment 8b are installed are determined in an early stage, the layout on the starboard side and the port side is facilitated. In addition, since the devices in the starboard side liquefaction equipment 8b and in the port side liquefaction equipment 8b are designed to be equal-sized, the design for one side can be used for the design for the other side, whereby the design of the liquefaction equipment 8b itself is facilitated.

[0039] The floating structure 2 is constructed by reusing the tanks 6 installed in an existing floating structure, which eliminates the cost and construction period for manufacturing the tanks 6. Therefore, the floating structure 2 can be provided at low cost and with a short delivery time.

[0040] While in the floating structure 2 according to the above-described embodiment, the case has been described where the natural gas processing equipment 8 (liquefaction equipment 8b) is positioned on both sides of the tanks 6 in the width direction of the hull structure 4, the natural gas processing equipment 8 may be positioned on either side of both sides of the tanks 6.

[0041] Furthermore, in the floating structure 2 according to the above-described embodiment, it suffices if the pretreatment equipment 8a is positioned at an end of the hull structure 4 in the lengthwise direction. This means that the pretreatment equipment 8a may be positioned on the stern side, and the residential area 10, the laydown area 12, and the power unit 14 may be positioned on the bow side. The pretreatment equipment 8a may be divided and positioned on the bow and the stern. Furthermore, the power unit 14 may be positioned on one side or both sides of the tanks 6 in the width direction of the hull structure 4. Even in these cases, it is possible to ensure a large space that can adapt variations in the types and sizes of the devices.

[0042] Although not mentioned in the above-described embodiment, the pretreatment equipment 8a may be positioned on a side of the tanks 6 in the width direction of the hull structure 4, and the liquefaction equipment 8b may be positioned on at least one of the bow and the stern.

[0043] In the floating structure 2 according to the above-described embodiment, the case has been described as an example where the six tanks 6 are continuously positioned in the lengthwise direction of the hull structure 4, but the number of tanks 6 may be seven or more. For example, seven to nine tanks 6 may be continuously positioned in the lengthwise direction of the hull structure 4. While it is preferable that six or more tanks 6 are installed, it suffices if at least a plurality of tanks 6 are installed, and the number of tanks 6 may be from two to five.

[0044] In the above-described embodiment, the case has been described where the liquefaction equipment 8b is provided in two lines, but the present invention is not limited to this. The

liquefaction equipment 8b may be provided in one line, or may be provided in three or more lines.

[0045] Furthermore, in the above-described embodiment, the case has been described where the liquefaction equipment 8b is provided in two lines for one pretreatment equipment 8a, but the present invention is not limited to this. Separate pretreatment equipment 8a may be provided for each liquefaction equipment 8b. For example, the pretreatment equipment 8a may be provided in one line each on the starboard side and the port side so as to correspond to the liquefaction equipment 8b positioned on the starboard side and the port side of the hull structure 4.

[0046] Furthermore, in the above-described embodiment, the case has been described where the devices (heat exchanger and refrigeration circuit) in the two lines of the liquefaction equipment 8b are designed to be equal-sized, but the devices in one line of the liquefaction equipment 8b may be designed to have sizes different from those of the devices in the other line of the liquefaction equipment 8b. In this case, the production amount in one line of the liquefaction equipment 8b of the two lines of the liquefaction equipment 8b can be made larger than the production amount in the other line of the liquefaction equipment 8b.

[0047] Furthermore, in the above-described embodiment, the case has been described where the starboard side liquefaction equipment 8b and the port side liquefaction equipment 8b are positioned to face each other with the tanks 6 interposed therebetween, but the present invention is not limited to this. The starboard side liquefaction equipment 8b and the port side liquefaction equipment 8b may be positioned such that their positions in the lengthwise direction of the hull structure 4 are different (they do not overlap in the width direction of the hull structure 4). Furthermore, when the liquefaction equipment 8b is provided in a plurality of lines, all the liquefaction equipment 8b may be positioned on one side of the tanks 6 in the width direction of the hull structure 4.

[0048] Furthermore, in the above-described embodiment, the case has been described as an example where the tanks 6 were transferred from an existing LNG cargo ship, but the tanks 6 may be transferred from an existing floating structure. In this case, the existing floating structure may

be an FLNG or the like. That is, if the tanks 6 are used exclusively as storage tanks for non-corrosive liquefied natural gas, they can be reused.

[0049] Furthermore, in the above-described embodiment, the floating structure 2 having no self-propelled function has been described as an example, but the means of moving the floating structure 2 is not limited to particular means, and the floating structure 2 may have a self-propelled function.

Reference Signs List

[0050]	2	Floating structure
	4	Hull structure
	6	Tank
	8	Natural gas processing equipment
	8a	Pretreatment equipment
	8b	Liquefaction equipment
	10	Residential area
	12	Laydown area
	14	Power unit
	102	Floating structure
	104	Hull structure
	106	LNG tank
	108	Natural gas processing equipment

CLAIMS

1. A floating structure comprising:

tanks transferred from an existing LNG cargo ship or an existing floating structure, and

positioned continuously in a lengthwise direction of a hull structure; and

a natural gas processing equipment positioned on at least one side among both sides of
the tanks in a width direction of the hull structure, wherein

the natural gas processing equipment is positioned on an inside in the width direction of
the hull structure.
2. The floating structure according to claim 1, wherein

the natural gas processing equipment is positioned on both sides of the tanks.
3. The floating structure according to claim 1 or 2, wherein

the natural gas processing equipment is positioned along a starboard side of the hull
structure and a port side of the hull structure.
4. The floating structure according to any one of claims 1 to 3, wherein

the natural gas processing equipment includes a pretreatment equipment for pretreating
natural gas and a liquefaction equipment for liquefying natural gas,

wherein the pretreatment equipment is positioned at an end of the hull structure in the
lengthwise direction, and

the liquefaction equipment is positioned on the inside in the width direction of the hull
structure.
5. The floating structure according to any one of claims 1 to 4, wherein

the natural gas processing equipment includes a pretreatment equipment for pretreating

natural gas and a liquefaction equipment for liquefying natural gas,

wherein the liquefaction equipment is positioned on the inside in the width direction of the hull structure and is provided in two lines, and

one line of the liquefaction equipment is positioned on a starboard side of the hull structure, and another line of the liquefaction equipment is positioned on a port side of the hull structure.

6. The floating structure according to claim 4 or 5, wherein

the liquefaction equipment and the tanks are connected through pipes for feeding liquefied natural gas liquefied by the liquefaction equipment to the tanks.

7. The floating structure according to any one of claims 1 to 6, wherein

the tanks include six or more tanks continuously positioned in the lengthwise direction of the hull structure.

8. The floating structure according to any one of claims 1 to 7, wherein

the tanks are spherical tanks.