

GAS TREATMENT SYSTEM AND SHIP INCLUDING THE SAME

TECHNICAL FIELD

[001] The present invention relates to a gas treatment system and a ship including the same.

BACKGROUND ART

[002] A ship is a transport vehicle for sailing across the ocean while carrying bulk of minerals, crude oil, natural gas, several thousands of containers, etc. A ship is made of steel and moves by propulsion generated through the rotation of a propeller in a state in which the ship is floating on a water plane by buoyancy.

[003] A ship generates propulsion by driving an engine, a gas turbine, or the like. The engine moves a piston using a gasoline, diesel or the like, and rotates a crankshaft by a reciprocating motion performed by the piston, so that a shaft connected to the crankshaft rotates to drive the propeller. On the other hand, the gas turbine generates power by burning fuel together with compressed air and rotating turbine blades through the temperature/pressure of the compressed air, and transfers the generated power to a propeller.

[004] However, recently, a Liquefied Natural Gas (LNG) carrier has used an LNG fuel supplying method of driving an engine, a turbine, or the like by using LNG as fuel. Since LNG is clean fuel and LNG deposits are greater than oil reserves, the LNG fuel supplying method has also been used in other ships in addition to the LNG carrier.

[005] Unlike diesel oil, LNG should be maintained in an extremely low temperature state so as to maintain a liquid state in loading/unloading. Therefore, research and development of a technique for stably bunkering LNG in ships except LNG carriers using an LNG propulsion

method has been required.

DISCLOSURE

TECHNICAL PROBLEM

[006] The present invention is conceived to solve the aforementioned problems. Accordingly, an object of the present invention is to improve bunkering efficiency by stably and rapidly transferring liquefied gas in a process of bunkering the liquefied gas in a gas propulsion ship.

TECHNICAL SOLUTION

[007] In accordance with an aspect of the present invention, there is provided a gas treatment system for transferring liquefied gas from a storage tank of a bunkering ship to a C-type fuel tank provided in a gas propulsion ship, the gas treatment system, including: a bunkering line configured to supply the liquefied gas of the storage tank to the fuel tank; a bunkering management part configured to control an internal pressure of the storage tank by liquefying evaporation gas of the storage tank, using a refrigerant, and returning the evaporation gas; and an evaporation gas return line configured to transfer evaporation gas generated in the fuel tank to the bunkering ship in bunkering through the bunkering line, wherein the bunkering management part lowers the internal pressure of the storage tank to a predetermined pressure or lower before the bunkering, and allow the evaporation gas to be transferred through the evaporation gas return line without compression performed by a separate compressor, by maintaining the internal pressure of the storage tank to be less than that of the fuel tank in the bunkering.

[008] Specifically, the storage tank may be a membrane-type or C-type tank. The predetermined pressure may be 0.04 barG or 0.2 barG.

[009] Specifically, the bunkering management part may include a reliquefaction apparatus configured to liquefy evaporation gas. The evaporation gas return line may transfer the evaporation gas to the reliquefaction apparatus.

[010] Specifically, the bunkering management part may maintain the internal pressure of the storage tank to be less than that of the fuel tank, by reliquefying the evaporation gas transferred through the evaporation gas return line in the bunkering and returning the reliquefied evaporation gas to the storage tank.

[011] Specifically, when the internal pressure of the fuel tank before bunkering is the first pressure, and the bunkering is performed on the fuel tank of which the internal pressure drops due to introduction of the liquefied gas in the bunkering, the bunkering management part may allow internal pressures of the storage tank before the bunkering and in the bunkering to be equal to or lower than that of the fuel tank when the bunkering of the fuel tank is completed.

[012] Specifically, when the internal pressure of the fuel tank is a second pressure, and the bunkering is performed on the fuel tank of which the internal pressure rises due to generation of the evaporation gas in the bunkering, the bunkering management part may allow internal pressures of the storage tank before the bunkering and in the bunkering to be equal to or lower than that of the fuel tank when the bunkering of the fuel tank is started.

[013] Specifically, the first pressure may be a pressure which is equal to the predetermined pressure or is higher by 0.05 barG to 0.1 barG than the predetermined pressure, and the second pressure may be a pressure which is lower by 0.05 barG to 0.1 barG than the predetermined pressure.

[014] Specifically, the first pressure may be 0.5 barG to 8 barG, and the second pressure may be 0.5 barG or lower.

[015] In accordance with another aspect of the present invention, there is provided a gas treatment system for transferring liquefied gas from a storage tank of a bunkering ship to a fuel tank provided in a gas propulsion ship, the gas treatment system, including: a bunkering line configured to supply the liquefied gas of the storage tank to the fuel tank; a bunkering management part configured to control an internal pressure of the storage tank by compressing, cooling, and decompressing evaporation gas of the storage tank without heat exchange with a refrigerant and returning the evaporation gas; and an evaporation gas return line configured to transfer evaporation gas generated in the fuel tank to the bunkering ship in bunkering through the bunkering line, wherein the bunkering management part: lowers the internal pressure of the storage tank to be a predetermined pressure or lower before the bunkering; and allows the fuel tank to be pressure-accumulated by blocking the transfer of the evaporation gas through the evaporation gas return line in the bunkering or allows the evaporation gas to be transferred through the evaporation gas return line without compression performed by a separate compressor by maintaining the internal pressure of the storage tank to be less than that of the fuel tank.

[016] Specifically, the storage tank may be a membrane-type or C-type tank. The predetermined pressure may be 0.04 barG or 0.2 barG.

[017] Specifically, the bunkering management part may include an evaporation gas heat exchanger configured to heat-exchange compressed evaporation gas with evaporation gas discharged from the storage tank. The evaporation gas return line may transfer evaporation gas between the storage tank and the evaporation gas heat exchanger.

[018] Specifically, the evaporation gas return line may be provided to transfer evaporation gas between the storage tank and the evaporation gas heat exchanger by passing through or detouring the evaporation gas heat exchanger.

[019] Specifically, the bunkering management part may include: a plurality of low-pressure compressors provided in parallel to compress evaporation gas of the storage tank and then supply the evaporation gas to a generator engine; a multi-stage boosting compressor provided at a position branching off between the low-pressure compressor and the generator engine, the multi-stage boosting compressor compressing surplus evaporation gas to 150 barG or higher; and a decompression valve configured to decompress and liquefy the evaporation gas compressed by the boosting compressor. The evaporation gas heat exchanger may cool high-pressure evaporation gas, using evaporation gas discharged from the storage tank, between the boosting compressor and the decompression valve.

[020] Specifically, the bunkering management part may suck the evaporation gas of the storage tank by operating, in parallel, the plurality of low-pressure compressors to lower the internal pressure of the storage tank to the predetermined pressure before the bunkering.

[021] Specifically, the bunkering management part may include: a low pressure compressor configured to compress evaporation gas of the storage tank and supply the evaporation gas to a generator engine; a multi-stage high-pressure compressor provided in parallel to the low-pressure compressor, the multi-stage high-pressure compressor compressing the evaporation gas of the storage tank to 150 barG or higher; and a decompression valve configured to decompress and liquefy the evaporation gas compressed by the high-pressure compressor. The evaporation gas heat exchanger may cool high-pressure evaporation gas, using evaporation gas discharged from the storage tank, between the high-pressure compressor and the decompression valve. The high-pressure compressor may supply evaporation gas of an intermediate stage to the generator engine.

[022] Specifically, the bunkering management part may

independently operate the low-pressure compressor and the high-pressure compressor according to a liquefied gas storage volume of the storage tank.

[023] In accordance with still another aspect of the present invention, there is provided a gas treatment system for transferring liquefied gas from a storage tank of a bunkering ship to a fuel tank provided in a gas propulsion ship, the gas treatment system, including: a bunkering line configured to supply the liquefied gas of the storage tank to the fuel tank; a bunkering management part configured to control an internal pressure of the storage tank by supercooling liquefied gas of the storage tank, using a refrigerant, and returning the liquefied gas; and an evaporation gas return line configured to transfer evaporation gas generated in the fuel tank to the bunkering ship in bunkering through the bunkering line, wherein the bunkering management part: lowers the internal pressure of the storage tank to be a predetermined pressure or lower before the bunkering; and allows the fuel tank to be pressure-accumulated by blocking the transfer of the evaporation gas through the evaporation gas return line in the bunkering or allows the evaporation gas to be transferred through the evaporation gas return line without compression performed by a separate compressor by maintaining the internal pressure of the storage tank to be less than that of the fuel tank.

[024] Specifically, the storage tank may be a membrane-type or C-type tank. The predetermined pressure may be 0.04 barG or 0.2 barG.

[025] Specifically, the bunkering management part may include: a supercooling apparatus configured to supercool liquefied gas, using a refrigerant; and a refrigerant supply part configured to supply the refrigerant to the supercooling apparatus. The refrigerant supply part may include a refrigerant heat exchanger configured to cool the refrigerant, using liquefied gas or evaporation gas, which is supplied from the storage tank to a generator engine.

[026] Specifically, the refrigerant supply part may include: a refrigerant compressor; an inter-refrigerant heat exchanger configured to heat-exchange a compressed refrigerant with a refrigerant heated in the supercooling apparatus; a refrigerant expander configured to expand the refrigerant passing through the inter-refrigerant heat exchanger after compression; and the refrigerant heat exchanger configured to cool the compressed refrigerant, using the liquefied gas or the evaporation gas, which is supplied to the generator engine.

[027] Specifically, the refrigerant supply part may include: a refrigerant compressor; the refrigerant heat exchanger configured to heat-exchange a compressed refrigerant with a refrigerant heated in the supercooling apparatus and liquefied gas or evaporation gas, which is supplied to the generator engine; and a refrigerant expander configured to expand the refrigerant passing through the refrigerant heat exchanger after compression.

[028] In accordance with still another aspect of the present invention, there is provided a bunkering ship including the gas treatment system.

ADVANTAGEOUS EFFECTS

[029] In the gas treatment system and the ship including the same in accordance with the present invention, a technique for reducing bunkering time and efficiency is created by considering that evaporation gas is generated from liquefied gas when the liquefied gas is transferred from a bunkering ship to a gas propulsion ship. Accordingly, safe and stable bunkering can be ensured.

BRIEF DESCRIPTION OF THE DRAWINGS

[030] FIG. 1 is a process flowchart of gas treatment systems in accordance with first and second embodiments of the present invention.

- [031] FIG. 2 is a conceptual view of the gas treatment system in accordance with the first embodiment of the present invention.
- [032] FIG. 3 is a graph illustrating internal pressure changes in the gas treatment system in accordance with the first embodiment of the present invention.
- [033] FIG. 4 is a conceptual view of the gas treatment system in accordance with the second embodiment of the present invention.
- [034] FIG. 5 is a graph illustrating internal pressure changes in the gas treatment system in accordance with the second embodiment of the present invention.
- [035] FIG. 6 is a process flowchart of a gas treatment system in accordance with a third embodiment of the present invention.
- [036] FIG. 7 is a process flowchart of a gas treatment system in accordance with a fourth embodiment of the present invention.
- [037] FIG. 8 is a process flowchart of a gas treatment system in accordance with a fifth embodiment of the present invention.
- [038] FIG. 9 is a process flowchart of a gas treatment system in accordance with a sixth embodiment of the present invention.
- [039] FIG. 10 is a process flowchart of a gas treatment system in accordance with a seventh embodiment of the present invention.
- [040] FIG. 11 is a process flowchart of a gas treatment system in accordance with an eighth embodiment of the present invention.
- [041] FIG. 12 is a process flowchart of a gas treatment system in accordance with a ninth embodiment of the present invention.
- [042] FIG. 13 is a process flowchart of a gas treatment system in accordance with a tenth embodiment of the present invention.

MODE FOR THE INVENTION

[043] Other objects, specific advantages, and new features of the present invention will be more apparent from preferable embodiments and the following detailed description associated with the accompanying drawings. In the specification, when reference numerals are endowed to components in each drawing, it should be noted that like reference numerals denote like elements even though they are depicted in several drawings. Further, in the following description of the present invention, a detailed explanation of known related technologies may be omitted to avoid unnecessarily obscuring the subject matter of the present invention.

[044] Hereinafter, exemplary embodiments of the present invention will be described in detail with reference to the accompanying drawings. For reference, in this specification, liquefied gas may be LNG, but the present invention is not limited thereto. The liquefied gas may include all materials which are forcibly liquefied to be stored since the boiling point of the liquefied gas is lower than room temperature, and have heating values

[045] Also, in this specification, liquefied gas/evaporation gas are distinguished from each other, based on states in a tank, and are not necessarily limited to a liquid phase or a gaseous phase due to names thereof. Also, in this specification, high pressure/low pressures are relative to each other, and are not limited to numerical values.

[046] For reference, first and second embodiments described below with reference to FIGS. 1 to 5 are based on a technical concept of lowering the tank internal pressure of a bunkering ship BV by completely reliquefying evaporation gas, using a refrigerant, so that the generation of the evaporation gas in bunkering is reduced.

[047] Hereinafter, each embodiment will be described in detail.

[048] FIG. 1 is a process flowchart of gas treatment systems in accordance with first and second embodiments of the present invention. FIG. 2 is a conceptual view of the gas treatment system in accordance with the first embodiment of the present invention. FIG. 3 is a graph illustrating internal pressure changes in the gas treatment system in accordance with the first embodiment of the present invention.

[049] Referring to FIGS. 1 to 3, the gas treatment system in accordance with the first embodiment of the present invention is a bunkering system which transfers liquefied gas from a storage tank 110 of a bunkering ship BV to a fuel tank 210a provided in a gas propulsion ship GFS.

[050] The present invention may include the bunkering ship BV having the gas treatment system described below. The present invention also includes the gas propulsion ship GFS in a configuration is specified so as to implement the gas treatment system. In an example, the present invention may include, as the gas propulsion ship GFS to which the following gas treatment system is applied, a gas propulsion ship in which a compressor (particularly, an H/D compressor) for returning evaporation gas generated in bunkering to the bunkering ship BV is not provided.

[051] For reference, the gas propulsion ship GFS is a merchant ship except a liquefied gas carrier and may be a kind of ship such as a bulk carrier, a container carrier, or a mineral carrier. The gas propulsion ship GFS may be provided with an equipment for allowing liquefied gas or evaporation gas, which is stored in the fuel tank 210a, to be compressed/pressurized/heated by a fuel treatment part 220 (a pump, a compressor, a heat exchanger, etc.), and supplying the liquefied gas or evaporation gas to a propulsion engine 230 through a gas supply line L6.

[052] The gas treatment system may include a configuration for supplying liquefied gas from the storage tank 110 to the fuel tank 210a. The storage tank 110 may be a membrane-type or C-type tank, and the liquefied gas may be transferred to the fuel tank 210a along a bunkering line L1 connecting the storage tank 110 and the fuel tank 210a by a transfer pump 111 provided in the storage tank 110.

[053] Also, the gas treatment system includes a configuration for returning, to the bunkering ship BV evaporation, gas generated in the fuel tank 210a when the liquefied gas is supplied to the fuel tank 210a. The fuel tank 210a may be of a C-type having a design pressure of about 5 barG to 10 barG in this embodiment, and be installed at various positions such as the top of a deck of the gas propulsion ship GFS and the inside of the gas propulsion ship GFS. The evaporation gas generated in the fuel tank 210a may be returned to the bunkering ship BV through an evaporation gas return line L2, and be directly/indirectly transferred to the storage tank 110.

[054] Also, the gas treatment system includes a bunkering management part 120. The bunkering management part 120 controls an internal pressure of the storage tank 110. In an example, the bunkering management part 120 may lower the internal pressure of the storage tank 110 by liquefying the evaporation gas of the storage tank 110, using a refrigerant (nitrogen, a refrigerant mixture, etc. without restriction), and returning the liquefied gas to the storage tank 110.

[055] In the present invention, the bunkering management part 120 described in detail below is provided, so that the generation of the evaporation gas in the fuel tank 210a in bunkering for supplying the liquefied gas of the storage tank 110 to the fuel tank 210a through the bunkering line L1 and the return of the evaporation gas generated in the fuel tank 210a to the bunkering ship BV can be improved as compared with the conventional art.

[056] Specifically, the bunkering management part 120 may lower the internal pressure of the storage tank 110 to a predetermined pressure or lower before bunkering. In an example, the bunkering management part 120 may lower, in advance, the internal pressure of the storage tank 110 to a predetermined pressure of 0.04 barG, 0.2 barG, or the like, before the liquefied gas is transferred through the bunkering line L1. When the internal pressure of the storage tank 110 has already satisfied the predetermined pressure or lower, the liquefaction and return of the evaporation gas may be omitted.

[057] That is, in the present invention, the internal pressure of the storage tank 110 of the bunkering ship BV is lowered in advance, so that the liquefied gas transferred from the storage tank 110 to the fuel tank 210a becomes a sufficiently stable liquid state (e.g., a supercooled state). Accordingly, a volume of evaporation gas generated when the liquefied gas is supplied to the fuel tank 210a can be reduced.

[058] Subsequently, when bunkering is started, the bunkering management part 120 maintains the internal pressure of the storage tank 110 to less than that of the fuel tank 210a. Evaporation gas generated in the fuel tank 210a does not require compression performed by a separate compressor in a process of transferring the evaporation gas to the bunkering ship BV through the evaporation gas line L2. That is, in the present invention, evaporation gas (NBOG) returned to the bunkering ship BV from the gas propulsion ship GFS in a bunkering process is transferred without compression (freeflow).

[059] Specifically, in the present invention, the evaporation gas of the storage tank 110 is continuously treated in the bunkering process, so that the internal pressure of the storage tank 110 is maintained lower than that of the fuel tank 210a. Thus, the evaporation gas is transferred from the fuel tank 210a to the storage tank 110 without compression, and accordingly, a high-duty compressor provided in the

gas propulsion ship GFS to return the evaporation gas in bunkering can be omitted. To this end, a pressure gauge (not shown) for internal pressure measurement is provided in each of the storage tank 110 and the fuel tank 210a.

[060] The bunkering management part 120 for implementing this effect uses a reliquefaction apparatus 122 for liquefying evaporation gas. A plurality evaporation gas compressors 121 are provided in parallel upstream of the reliquefaction apparatus 122 to back up each other, and a pressure control valve 123 and a gas-liquid separator 124 are provided downstream of the reliquefaction apparatus 122.

[061] The evaporation gas compressor 121, the pressure control valve 123, and the gas-liquid separator 124 may be sequentially provided on a pressure control line L3 forming a circulation flow path with respect to the storage tank 110, and accordingly, the bunkering management part 120 can lower the internal pressure of the storage tank 110 by compressing and liquefying evaporation gas of the storage tank 110 and returning the evaporation gas to the storage tank 110.

[062] In the present invention, in order to maintain the internal pressure of the storage tank 110 to be low, the evaporation gas to the bunkering ship BV through the evaporation gas return line L2 may be transferred to the reliquefaction apparatus 122 to be reliquefied and then returned to the storage tank 110, or be transferred to the storage tank 110 by detouring the reliquefaction apparatus 122. Alternatively, the evaporation gas transferred from the gas propulsion ship GFS may be used for an operation of a generator engine 130 for power consumption in the bunkering ship BV.

[063] In order to allow the internal pressure of the storage tank 110 to be equal to or lower than that of the fuel tank 210a, i.e., in order to allow the internal pressure of the fuel tank 210a to be higher than that of the storage tank 110, the bunkering management part 120 may use

the reliquefaction apparatus 122 such that the internal pressure of the storage tank 110 does not rise when the evaporation gas transferred through the evaporation gas return line L2 is immediately introduced to the storage tank 110.

[064] That is, the bunkering management part 120 reliquefies the evaporation gas returned in bunkering and returns the reliquefied gas to the storage tank 110, so that the internal pressure of the storage tank 110 can be maintained to be less than that of the fuel tank 210a. The evaporation gas return line L2 may be provided to join an inlet of the evaporation gas compressor 121 as an upper stream of the reliquefaction apparatus 122 or to be directly connected to the reliquefaction apparatus 122. When the internal pressure of the fuel tank 210a corresponds to the pressure of a lower stream of the evaporation gas compressor 121, the evaporation gas may be directly transferred from the evaporation gas return line L2 to the reliquefaction apparatus 122.

[065] Since the duty of the transfer pump 111 become larger as the internal pressure of the storage tank 110 becomes lower, the bunkering management part 120 may allow the internal pressure of the storage tank 110 to rise by supplying the returned evaporation gas to the storage tank 110 without reliquefaction in a state in which the internal pressure of the storage tank 110 is equal to or lower than that of the fuel tank 210a.

[066] Since the bunkering ship BV necessarily secures relatively large power so as to operate the reliquefaction apparatus 122, the evaporation gas compressor 121, the transfer pump 111, and the like in an anchoring state for bunkering, the generator engine 130 is to be operated in anchoring. The generator engine 130 may receive and consume evaporation gas supplied through an evaporation gas consumption line L4 branching off from the lower stream of the

evaporation gas compressor 121 on the pressure control line L3. To this end, a discharge pressure of the evaporation gas compressor 121 may correspond to a required pressure of the generator engine 130.

[067] The generator engine 130 may receive and consume liquefied gas passing through a fuel supply pump 112 and an evaporator 113 through a liquefied gas consumption line L5. However, the evaporation gas consumption line L4 may be additionally connected to a gas combustion apparatus 140 (or a boiler, etc.) so as to consume the evaporation gas in a situation such as a case where the generator engine 130 is not operated.

[068] The evaporation gas returned through the evaporation gas return line L2 may also be used as fuel of the generator engine 130, etc. The evaporation gas return line L2 may be connected upstream of the evaporation gas compressor 121, but the present invention is not limited thereto.

[069] Hereinafter, a bunkering process will be described with reference to FIG. 3. For reference, in FIG. 3, a solid line represents internal pressure changes in bunkering of the fuel tank 210a having different initial internal pressures, a slope dotted line represents volumes of liquefied gas on which bunkering is performed, and a horizontal dotted line represent internal pressures of the storage tank 110.

[070] First, before bunkering, the gas treatment system may lower the internal pressure of the storage tank 110 of the bunkering ship BV to a predetermined pressure or lower by using the reliquefaction apparatus 122. The predetermined pressure is about 0.2 barG in (A) of FIG. 3, and is 0.04 barG in (B) of FIG. 3.

[071] When the internal pressure of the storage tank 110 is sufficiently lowered, the bunkering is started by connecting the bunkering line L1 between the storage tank 110 and the fuel tank 210a.

The fuel tank 210a may have a cool-down state therein to receive an extremely low temperature liquefied gas, but a large volume of evaporation gas is generated in the fuel tank 210a due to a factor such as a case where heat penetrates into the fuel tank 210a during the bunkering.

[072] The evaporation gas is to be returned to the bunkering ship BV so as to protect the fuel tank 210a. In the present invention, as shown in FIG. 3, the internal pressure of the storage tank 110 becomes equal to or lower than that of the fuel tank 210a throughout a time for the bunkering is performed, so that the returned evaporation gas can be transferred without compression.

[073] As for the fuel tank 210a on which the bunkering is performed, the internal pressure of the fuel tank 210a before the bunkering may be, for example, 0.2/3.0/6.5 barG. When an initial pressure of the fuel tank 210a is 3.0 barG or 6.5 barG as shown in (A) of FIG. 3, the internal pressure of the fuel tank 210a is gradually lowered as liquefied gas is supplied. Therefore, the gas propulsion ship GFS on which the bunkering has been completely performed becomes a state in which the gas propulsion ship GFS can be immediately propelled without treatment on the evaporation gas of the fuel tank 210a. This is because the bunkering is performed on the storage tank 110 after the internal pressure of the storage tank 110 is lowered before the bunkering.

[074] However, in (A) of FIG. 3, the initial pressure of the fuel tank 210a may be 0.2 barG, which is equal to the predetermined pressure of the storage tank 110. The internal pressure of the fuel tank 210a may rise to a certain degree in a bunkering process as evaporation gas is generated while the fuel tank 210a receives the liquefied gas of the storage tank 110 of which the internal pressure is equal to that of the fuel tank 210a.

[075] On the other hand, in (B) of FIG. 3, even when the initial internal pressure of the fuel tank 210a is 0.2 barG, the internal pressure of the storage tank 110 before the bunkering is prepared as 0.04 barG which is lower than 0.2 barG. Hence, it can be seen that internal pressures of the fuel tank 210a having three initial internal pressures are all lowered in the bunkering process.

[076] The bunkering management part 120 may maintain a pressure difference between the storage tank 110 and the fuel tank 210a such that the evaporation gas can still be returned to the bunkering ship BV from the gas propulsion ship GFS without compression in all the above-described examples.

[077] Specifically, when the internal pressure of the fuel tank 210a before the bunkering is a first pressure, and the bunkering is performed on the fuel tank 210a of which the internal pressure drops due to introduction of the liquefied gas in the bunkering (a case where the internal pressure of the fuel tank 210a is 3.0/6.5 barG in (A) of FIG. 3 and all cases in (B) of FIG. 3), the bunkering management part 120 may allow the internal pressures of the storage tank 110 before the bunkering and in the bunkering to be equal to or lower than that (about 0.5 barG) of the fuel tank 210a when the bunkering is completely performed on the fuel tank 210a.

[078] On the other hand, when the internal pressure of the fuel tank 210a before the bunkering is a second pressure, and the bunkering is performed on the fuel tank 210a of which the internal pressure rises due to generation of the evaporation gas in the bunkering (a case where the internal pressure of the fuel tank 210a is 0.2 barG in (A) of FIG. 3), the bunkering management part 120 may allow the internal pressures of the storage tank 110 before the bunkering and in the bunkering to be equal to or lower than that (0.2 barG) of the fuel tank 210a when the bunkering of the fuel tank 210a is started.

[079] The first pressure is a pressure which is equal to the predetermined pressure or is higher by 0.05 barG to 0.1 barG than the predetermined pressure, and may be 0.5 barG to 8 barG. The second pressure is a pressure which is lower by 0.05 barG to 0.1 barG than the predetermined pressure, and may be 0.5 barG or lower. However, the first and second pressures are not limited to numerical numbers.

[080] As described above, in this embodiment, the internal pressure of the storage tank 110 is lowered in advance before the bunkering, so that the evaporation gas generated in the fuel tank 210a in the bunkering can be reduced. Further, the evaporation gas of the fuel tank 210 is returned to the bunkering ship BV without compression by maintaining the internal pressure of the storage tank 110 to be equal to or lower than that of the fuel tank 210a, so that the H/D compressor of the gas propulsion ship GFS can be omitted.

[081] FIG. 4 is a conceptual view of the gas treatment system in accordance with the second embodiment of the present invention. FIG. 5 is a graph illustrating internal pressure changes in the gas treatment system in accordance with the second embodiment of the present invention.

[082] Referring to FIGS. 4 and 5 together with FIG. 1, the second embodiment of the present invention is different from the above-described embodiment, in that a fuel tank 210b is provided as a membrane-type tank. Hereinafter, portions different from those of the above-described embodiment will be mainly described, and portions which will not be described below are the same as those of the above-described embodiment. This will be the same as other embodiments which will be described later.

[083] The gas propulsion ship GFS of this embodiment is a container carriers, etc. as shown in FIG. 4, and may load the fuel tank 210b therein. The fuel tank 210b may be of a membrane-type.

Alternatively, the fuel tank 210b is an independent tank having a design pressure equal/similar to that of the membrane type tank, and may be of a B-type (SPB, etc. as self-supporting prismatic type).

[084] Hereinafter, the bunkering process of this embodiment will be described. For reference, like FIG. 3, in FIG. 5, a solid line represents internal pressure changes in bunkering of the fuel tank 210b having different initial internal pressures, a slope dotted line represents volumes of liquefied gas on which bunkering is performed, and a horizontal dotted line represent internal pressures of the storage tank 110.

[085] The gas treatment system may lower the internal pressure of the storage tank 110 to a predetermined pressure or lower before bunkering. The predetermined pressure is about 0.2 barG in (A) of FIG. 5, and is 0.04 barG in (B) of FIG. 5.

[086] The bunkering is started after the internal pressure of the storage tank 110 is lowered in advance. Like the first embodiment, in the second embodiment, the internal pressure of the storage tank 110 becomes equal to or lower than that of the fuel tank 210b throughout a time for the bunkering is performed, so that evaporation gas is returned to the bunkering ship BV from the fuel tank 210b without compression performed by the HD compressor.

[087] The internal pressure of the fuel tank 210b before the bunkering may be 0.63/0.2/0.05 barG. When the internal pressure of the fuel tank 210b is 0.63 barG in (A) of FIG. 5, in which the internal pressure of the storage tank 110 before the bunkering is 0.2 barG, and when the internal pressure of the fuel tank 210b is 0.63/0.2 barG in (B) of FIG. 5, in which the internal pressure of the storage tank 110 before the bunkering is 0.04 barG, the internal pressure of the fuel tank 210b is gradually lowered as liquefied gas is supplied.

[088] This case is a case where the internal pressure of the fuel tank

210b before the bunkering is a first pressure (as a pressure equal to the predetermined pressure or higher by 0.05 barG to 0.1 barG than the predetermined pressure, which is 0.5 barG to 1 barG), and the bunkering is performed on the fuel tank 210b of which the internal pressure drops due to introduction of the liquefied gas in the bunkering. The bunkering management part 120 may allow the internal pressures of the storage tank 110 before the bunkering and in the bunkering to be equal to or lower than that (about 0.5 barG) of the fuel tank 210a when the bunkering is completely performed on the fuel tank 210a.

[089] On the other hand, when the internal pressure of the fuel tank 210b is 0.2 barG in (A) of FIG. 5, in which the internal pressure of the storage tank 110 before the bunkering is 0.2 barG, and when the internal pressure of the fuel tank 210b is 0.05 barG in (B) of FIG. 5, in which the internal pressure of the storage tank 110 before the bunkering is 0.04 barG, the internal pressure of the fuel tank 210b may rise to a certain degree in the bunkering process as the evaporation gas is generated while the fuel tank 210b receives the liquefied gas of the storage tank of which the internal pressure is equal/similar to that thereof.

[090] This case is a case where the internal pressure of the fuel tank 210b before the bunkering is a second pressure (as a pressure higher by 0.05 barG to 0.1 barG than the predetermined pressure, which is 0.5 barG or lower), and the bunkering is performed on the fuel tank 210b of which the internal pressure rises due to generation of the evaporation gas in the bunkering. The bunkering management part 120 may allow the internal pressures of the storage tank 110 before the bunkering and in the bunkering to be equal to or lower than that (0.2 barG) of the fuel tank 210a when the bunkering is started.

[091] However, in this embodiment, there exists a case where the internal pressure of the fuel tank 210b before the bunkering 0.05 barG

or lower in (A) of FIG. 5, in which the internal pressure of the storage tank 110 before the bunkering is 0.2 barG. This case is a case where the pressure of the storage tank 110 of which the internal pressure before the bunkering becomes lower than the predetermined pressure is a pressure higher than the internal pressure of the fuel tank 210b before the bunkering, and a treatment different from that in the first embodiment is performed.

[092] Since the internal pressure of the storage tank 110 is formed higher than that of the fuel tank 210b in initial bunkering, freeflow return of the evaporation gas is not made. Therefore, in this embodiment, the fuel tank 210b is pressure-accumulated by blocking transfer of the evaporation gas through the evaporation gas return line L2 from the time at which the bunkering is started to a certain time.

[093] When the return of the evaporation gas is blocked, the internal pressure of the fuel tank 210b gradually rises due the generation of the evaporation gas, and the evaporation gas may be transferred without compression through the evaporation gas return line L2 by maintaining the internal pressure of the storage tank 110 to be less than that of the fuel tank 210b through the bunkering management part 210 from a certain time at which the internal pressure of the fuel tank 210b is beyond that of the storage tank 110 to the time at which the bunkering is completed, like the above-described embodiment.

[094] That is, in this embodiment, when the bunkering is performed on the fuel tank 210b having a design pressure as atmospheric pressure, the internal pressure of the fuel tank 210b may be controlled to be beyond that of the storage tank 110 while the internal pressure of the fuel tank 210b rises due to the pressure-accumulation for a certain time from when the bunkering is started, so as to prepare for occurrence of a situation in which, although the internal pressure of the storage tank 110 is lowered in advance, the bunkering is started in a state in which

the internal pressure of the storage tank 110 is higher than that of the fuel tank 210b before the bunkering.

[095] Specifically, the bunkering management part 120 may block the return of the evaporation gas from the time at which the bunkering is started to a certain time, and maintain the internal pressure of the storage tank 110 to be less than that of the fuel tank 210b by reliquefying the returned evaporation gas and returning the reliquefied gas to the storage tank 110 from the certain time to the time at which the bunkering is completed.

[096] As described above, in this embodiment, in order to implement bunkering on the membrane-type fuel tank 210, partial pressure-accumulation control of the fuel tank 210b is implemented so as to prepare for a case where the internal pressure of the storage tank 110 is higher than that of the fuel tank 210b when the bunkering is started, so that any compressor is not required in the return of the evaporation gas.

[097] For reference, third and fourth embodiments described below with reference to FIGS. 6 and 7 are based on a technical concept of reducing occurrence of evaporation gas in bunkering by partially reliquefying the evaporation gas through compression/heat exchange/decompression and lowering the tank internal pressure of the bunkering ship BV.

[098] Hereinafter, each embodiment will be described in detail.

[099] FIG. 6 is a process flowchart of a gas treatment system in accordance with a third embodiment of the present invention.

[0100] Referring to FIG. 6, the gas treatment system in accordance with the third embodiment of the present invention may include a bunkering management part 120 for controlling the internal pressure of a storage tank 110 by compressing, cooling, and decompressing

evaporation gas of the storage tank 110 and then returning the evaporation gas without heat exchange with a refrigerant, instead of (or in addition to) the bunkering management part 120 including the reliquefaction apparatus 122 for liquefying the evaporation gas, using the refrigerant, and then returning the evaporation gas.

[0101] However, in the following embodiments including this embodiment, the control of the bunkering management part 120, which allows the fuel tank 210a and 210b to be pressure-accumulated by lowering the internal pressure of the storage tank 110 to be equal to or lower than a predetermined pressure (about 0.04/0.2 barG) before bunkering and blocking the return of evaporation gas, or maintains the internal pressure of the storage tank 110 to be higher than that of the fuel tank 210a and 210b such that the evaporation gas is transferred without compression in the bunkering, is the same as the above-described embodiments.

[0102] The bunkering management part 120 may include a low-pressure compressor 121a, a boosting compressor 121b, an evaporation gas heat exchange 125, a decompression valve 123, and a gas-liquid separator 124. A pressure control line L3 may form a circulation flow path with respect to the storage tank 110, and allow the above components to be sequentially connected in series.

[0103] The low-pressure compressor 121a is provided in plurality in parallel to compress evaporation gas of the storage tank 110 and then supply the evaporation gas to a generator engine 130. To this end, an evaporation gas consumption line L4 may branch off at a lower stream of the low-pressure compressor 121a to be connected to the generator engine 130, etc., and the low-pressure compressor 121a may have a discharge pressure suitable for a required pressure of the generator engine 130.

[0104] The boosting compressor 121b is provided in multiple stages.

The boosting compressor 121b is provided at a position (the lower stream of the low-pressure compressor 121a with respect to the pressure control line L3) at which the pressure control line L3 branch off between the low-pressure compressor 121a and the generator engine 130, and compresses surplus evaporation gas to have 150 barG or higher.

[0105] In this embodiment, a Joule-Thomson effect is used so as to liquefy evaporation gas without refrigerant heat exchange and then decompress the evaporation gas. To this end, the pressure of the evaporation gas before decompression is to be 150 barG or higher. Therefore, in this embodiment, the low-pressure compressor 121a is provided to supply evaporation gas to the generator engine 130, and the boosting compressor 121b is additionally provided to liquefy the evaporation gas by using decompression.

[0106] The evaporation gas heat exchanger 125 may heat-exchange evaporation gas compressed by the boosting compressor 121b with evaporation gas discharged from the storage tank 110, and cool the compressed high-pressure evaporation gas. On the other hand, since the evaporation gas discharged from the storage tank 110 is heated to a certain degree due to the heat exchange in the evaporation gas heat exchanger 125, an introduction temperature of the low-pressure compressor 121a rises, and thus a temperature at which the low-pressure compressor 121a is to endure can be increased.

[0107] The evaporation gas heat exchanger 125 has a structure including at least two streams such that the stream of evaporation gas transferred from the storage tank 110 to the low-pressure compressor 121a and the stream of evaporation gas transferred from the boosting compressor 121b to the decompression valve 123 are heat-exchanged with each other.

[0108] Since an evaporation gas return line L2 is provided to transfer

evaporation gas between the storage tank 110 and the evaporation gas heat exchanger 125, the stream of the evaporation gas transferred from the storage tank 110 to the low-pressure compressor 121a may be a stream in which evaporation gas of the fuel tank 210a and 210b is mixed with that of the storage tank 110.

[0109] In addition, the evaporation gas heat exchanger 125 may additionally have a stream through which the evaporation gas return line L2 passes such that the evaporation gas of the fuel tank 210a and 210b, which is transferred through the evaporation gas return line L2. That is, the evaporation gas return line L2 may pass through the evaporation gas heat exchanger 125 and then join the pressure control line L3 between the storage tank 110 and the low-pressure compressor 121a.

[0110] However, the evaporation gas return line L2 may be provided to detour the evaporation gas heat exchanger 125. Hence, the evaporation gas return line L2 is provided to transfer the evaporation gas between the storage tank 110 and the evaporation gas heat exchanger 125 while passing through or detouring the evaporation gas heat exchanger 125.

[0111] The evaporation gas return line L2 detours the evaporation gas heat exchanger 125 when it is unnecessary to use heat of evaporation gas collected to the gas propulsion ship GFS. This case may be a case where the volume of surplus evaporation gas which is not supplied to the generator engine 130 but remains is small or none.

[0112] The decompression valve 123 decompresses and liquefies evaporation gas which is compressed by the boosting compressor 121b and is cooled by the evaporation gas heat exchanger 125. The decompression valve 123 may liquefy at least a portion of evaporation gas by decompressing, to 1 barG to 10 barG, the evaporation gas which is compressed to 150 barG or higher and then cooled.

[0113] The gas-liquid separator 124 allows a liquid phase (LBOG) to be returned to the storage tank 110 by performing gas-liquid separation on the liquefied evaporation gas, and a gaseous phase (flash gas) may be mixed with the evaporation gas transferred from the storage tank 110 to the evaporation gas heat exchanger 125.

[0114] Alternatively, the gaseous phase separated from the gas-liquid separator 124 may not be joined with the evaporation gas but be heat-exchanged while flowing through a separate stream in the evaporation gas heat exchanger 125, and then be joined with the evaporation gas at an upper stream of the low-pressure compressor 121a or be consumed by the generator engine 130, a boiler, or the like.

[0115] In the bunker management part 120 of this embodiment, an evaporation gas compressor 121 including the low-pressure compressor 121a and the boosting compressor 121b is configured, and the evaporation gas of the storage tank 110 is sufficiently sucked by operating, in parallel, a plurality of low-pressure compressor 121a so as to lower the internal pressure of the storage tank 110 before the bunkering to the predetermined pressure or lower, so that an internal pressure drop of the storage tank 110 can be rapidly implemented.

[0116] Thus, in this embodiment, the internal pressure of the storage tank 110 before the bunkering is rapidly and sufficiently lowered, so that the volume of evaporation gas generated in the storage tank 110 in the bunkering can be reduced. Accordingly, bunkering efficiency can be improved.

[0117] FIG. 7 is a process flowchart of a gas treatment system in accordance with a fourth embodiment of the present invention.

[0118] Referring to FIG. 7, in the gas treatment system in accordance with the fourth embodiment of the present invention, an evaporation gas compressor 121 of a bunkering management part 120 may be configured differently from that in the third embodiment.

[0119] The bunkering management part 120 of this embodiment is provided with a low-pressure compressor 121a for supplying evaporation gas to a generator engine 130 and a high-pressure compressor 121c for liquefying evaporation gas through the Joule-Thomson effect, and the low-pressure compressor 121a and the high-pressure compressor 121c may be provided in parallel.

[0120] An evaporation gas consumption line L4 is connected to an intermediate stage of the high-pressure compressor 121c, to supply evaporation gas compressed in the intermediate stage to the generator engine 130. Accordingly, the low-pressure compressor 121a can be backed up by a portion of the high-pressure compressor 121c provided in multiple stages.

[0121] The bunkering management part 120 of this embodiment may pressurize evaporation gas to 150 barG by using the high-pressure compressor 121c and then cool the evaporation gas by using evaporation gas discharged from a storage tank 110 in an evaporation gas heat exchanger 125. The bunkering management part 120 may return the evaporation gas to the storage tank 110 via a decompression valve 123 and a gas-liquid separator 124.

[0122] The bunkering management part 120 may independently select and operate the low-pressure compressor 121a and the high-pressure compressor 121c according to a liquefied gas storage volume of the storage tank 110. In an example, when the liquefied gas storage volume of the storage tank 110 is large (laden voyage having a large evaporation gas volume, etc.), the bunkering management part 120 may reliquefy evaporation gas in a final stage while supplying a portion of the evaporation gas of the intermediate stage to the generator engine 130 by using the high-pressure compressor 121c and return the evaporation gas to the storage tank 110. On the other hand, when the liquefied gas storage volume of the storage tank 110 is small (ballast

voyage having a small evaporation gas volume, etc.), the bunkering management part 120 may allow evaporation gas to be consumed by the generator engine 130, etc. and not to be returned to the storage tank 110 by using the low-pressure compressor 121a.

[0123] As described above, in this embodiment, the high-pressure compressor 121c for implementing evaporation gas liquefaction by using decompression is provided in parallel to the low-pressure compressor 121a for supplying evaporation gas to the generator engine 130, and one of the high-pressure compressor 121c and the low-pressure compressor 121a are selected and operated according to navigation state, so that the operational efficiency of the evaporation gas compressor 121 can be improved.

[0124] For reference, fifth to seventh embodiments described below with reference to FIGS. 8 to 10 are based on a technical concept of reducing occurrence of evaporation gas in bunkering by supercooling liquefied gas, using a refrigerant, and then returning the liquefied gas, and lowering the tank internal pressure of the bunkering ship BV.

[0125] Hereinafter, each embodiment will be described in detail.

[0126] FIG. 8 is a process flowchart of a gas treatment system in accordance with a fifth embodiment of the present invention.

[0127] Referring to FIG. 8, the gas treatment system in accordance with the fifth embodiment of the present invention may control the internal pressure of a storage tank 110 by supercooling liquefied gas, using a refrigerant, and then returning the liquefied gas, instead of that a bunkering management part 120 completely reliquefies evaporation gas, using the refrigerant, or partially reliquefies evaporation gas by compressing/cooling/decompressing the evaporation gas.

[0128] To this end, the bunkering management part 120 is provided with a supercooling apparatus 126 and a refrigerant supply part 127.

The supercooling apparatus 126 may supercool liquefied gas, using a refrigerant, and the temperature of the supercooled liquefied gas may be a temperature (e.g., about -170 °C) lower than a boiling point (-163 °C) of the liquefied gas at atmospheric pressure.

[0129] The refrigerant supply part 127 implements supercooling of the liquefied gas by supply, to the supercooling apparatus, a refrigerant as a substance which is not limited, such as nitrogen or a mixed refrigerant. The refrigerant supply part 127 is provided with a refrigerant compressor 1271, a refrigerant cooler 1272, a refrigerant expander 1273, a refrigerant heat exchanger 1274, and an inter-refrigerant heat exchanger 1275, and a refrigerant circulation line L7 forms a flow path through which the refrigerant circulates while sequentially connecting the above components.

[0130] The refrigerant compressor 1271 compresses the refrigerant. The pressure of the compressed refrigerant may be about 10 barG, but the present invention is not limited thereto. Pressures of various numerical values may be used to improve supercooling efficiency.

[0131] The refrigerant cooler 1272 may cool the refrigerant heated while being compressed by the refrigerant compressor 1271 by using various cooling energy. The refrigerant cooler 1272 is provided at a lower stream of the refrigerant compressor 1271. When the refrigerant compressor 1271 is provided in multiple stages, the refrigerant cooler 1272 may be provided in each stage of the refrigerant compressor 1271.

[0132] The refrigerant expander 1273 expands the compressed refrigerant. As for the refrigerant decompressed by expansion after compression, the temperature of the refrigerant may be sufficiently lowered, similarly to the above-described decompression valve 123. The expanded refrigerant may be transferred to the supercooling apparatus 126, to be used in supercooling of the liquefied gas.

[0133] The refrigerant heat exchanger 1274 cools the refrigerant

compressed by the refrigerant compressor 1271 by using evaporation gas supplied from the storage tank 110 to a generator engine 130. The refrigerant heat exchanger 1274 may be provided between the refrigerant compressor 1271 and the supercooling apparatus 126 as shown in the drawing. Alternatively, the refrigerant heat exchanger 1274 may be installed at any spot between the refrigerant compressor 1271 and the supercooling apparatus 126, and substitute for the refrigerant cooler 1272.

[0134] The inter-refrigerant heat exchanger 1275 may heat-exchange the compressed refrigerant with the refrigerant heated in the supercooling apparatus 126. Specifically, the inter-refrigerant heat exchanger 1275 may heat-exchange the refrigerant before expansion after compression with the refrigerant heated in the supercooling apparatus 126 before compression.

[0135] In this embodiment, the refrigerant supply part 127 may be provided in an N₂ Bryton cycle to have the inter-refrigerant heat exchanger 1275, but the inter-refrigerant heat exchanger 1275 may be omitted.

[0136] As described above, in this embodiment, the supercooling return of the liquefied gas is used to lower the internal pressure of the storage tank 110 before bunkering, and the refrigerant for supercooling uses heat of the evaporation gas supplied to the generator engine 130, so that energy use efficiency can be improved.

[0137] FIG. 9 is a process flowchart of a gas treatment system in accordance with a sixth embodiment of the present invention.

[0138] Referring to FIG. 9, in the gas treatment system in accordance with the sixth embodiment of the present invention, the refrigerant supply part 127 may cool a refrigerant by using liquefied gas supplied from the storage tank 110 to the generator engine 130, as compared with the fifth embodiment.

[0139] Liquefied gas of the storage tank 110 is supplied to the generator engine 130 via the evaporator 113. In this embodiment, liquefied gas to be evaporated is used in cooling of a refrigerant, so that the supercooling effect of the liquefied gas before bunkering is improved. At the same time, the duty of the evaporator 113 is lowered or the evaporator 113 may be omitted.

[0140] Unlike the above-described embodiment in which the refrigerant heat exchanger 1274 passes through the refrigerant circulation line L7 and the evaporation gas consumption line L4, the refrigerant heat exchanger 1274 of this embodiment is also provide to pass through the refrigerant circulation line L7 and the evaporation gas consumption line L4. Also, while the pump for supercooling the liquefied gas is the transfer pump 111 or a separate pump in the above-described embodiment, a fuel supply pump 112 may be used as the pump for supercooling the liquefied gas in this embodiment.

[0141] In addition, the present invention may include an embodiment in which the refrigerant is cooled, using at least one of the evaporation gas and the liquefied gas, which are supplied to the generator engine 130, by combining this embodiment and the above-described embodiment. The refrigerant heat exchanger 1274 having a refrigerant/liquefied gas/evaporation gas stream may be independently provided, or the refrigerant heat exchanger 1274 having a refrigerant/liquefied gas stream and the refrigerant heat exchanger 1274 having a refrigerant/evaporation gas stream may be provided.

[0142] FIG. 10 is a process flowchart of a gas treatment system in accordance with a seventh embodiment of the present invention.

[0143] Referring to FIG. 10, in the gas treatment system in accordance with the seventh embodiment of the present invention, the refrigerant heat exchanger 1274 is provided to substitute for the inter-refrigerant heat exchanger 1275.

[0144] That is, the refrigerant heat exchanger 1274 is configured with at least three streams for heat-exchanging a compressed refrigerant, a refrigerant heated in the supercooling apparatus 126, and liquefied gas or evaporation gas, which is supplied to the generator engine 130, to be provided in a structure including inter-refrigerant heat exchange.

[0145] Thus, in this embodiment, the inter-refrigerant heat exchanger 1275 is not separately provided, so that the configuration of the refrigerant supply part 127 can be compactly reduced.

[0146] For reference, in eighth to tenth embodiments described below with reference to FIGS. 11 to 13, a generator engine 130 is to be sufficiently operated so as to perform an operation of a transfer pump 111 in bunkering in the case of the bunkering ship BV, and hence the entire system is efficiently optimized by considering that a fuel consumption volume in an anchoring state is large, unlike the gas propulsion ship GFS.

[0147] Hereinafter, each embodiment will be described in detail.

[0148] FIG. 11 is a process flowchart of a gas treatment system in accordance with an eighth embodiment of the present invention.

[0149] Referring to FIG. 11, similarly to the contents disclosed in the above-described embodiments, the gas treatment system in accordance with the eighth embodiment of the present invention includes a bunkering management part 120 for controlling the internal pressure of a storage tank 110 by using a cooling apparatus 122 and 126 which cools liquefied gas or evaporation gas of the storage tank 110, using a refrigerant, and returns the cooled gas.

[0150] In this embodiment, an evaporation gas maximum return volume which the storage tank 110 can receive from the gas propulsion ship GFS may be directly/indirectly derived by assuming an operation of the cooling apparatus 122 and 126 for supercooling and returning

liquefied gas to enable the storage tank 110 to further receive evaporation gas or by assuming an operation of the cooling apparatus 122 and 126 for liquefying and returning evaporation gas returned from a fuel tank 210a and 210b. The evaporation gas maximum return volume may be set to be less than an evaporation gas flow volume transferred through a return line L2 in bunkering.

[0151] That is, evaporation gas returned from the gas propulsion ship GFS to the bunkering ship BV cannot all be treated only by operating the cooling apparatus 122 and 126. However, as described above, in this embodiment, the sum of an evaporation gas treatment volume of an evaporation gas compressor 121 for compressing evaporation gas of the storage tank 110 and supplying the evaporation gas to the generator engine 130 and the evaporation gas maximum return volume of the storage tank 110 in consideration of the cooling apparatus 122 and 126 may be equal to or greater than the evaporation gas flow volume returned in the bunkering, by considering that the bunkering ship BV has high required power in anchoring, as compared with the gas propulsion ship GFS.

[0152] This is summarized as follows.

[0153] Maximum return volume in consideration of cooling apparatus 122 and 126 < Return volume in bunkering < Maximum return volume in consideration of cooling apparatus 122 and 126 + Compressor treatment amount

[0154] That is, in this embodiment, resources of the cooling apparatus 122 and 126 are reduced by considering that sufficient evaporation gas is supplied to the generator engine 130 by the evaporation gas compressor 121 during the bunkering, so that CAPEX can be reduced. However, a plurality of evaporation gas compressors 121 may be provided in parallel, so that a parallel operation is possible, and the compressor treatment volume in the above expression may be a

treatment volume when the plurality of evaporation gas compressors 121 provided in parallel are all operated.

[0155] FIG. 12 is a process flowchart of a gas treatment system in accordance with a ninth embodiment of the present invention.

[0156] Referring to FIG. 12, in the gas treatment system in accordance with the ninth embodiment of the present invention, the entire system is optimized in a manner different from that of the above-described embodiment.

[0157] Specifically, the evaporation gas maximum return volume of the storage tank 110 in consideration of the cooling apparatus 122 and 126 is equal to or greater than the evaporation return flow volume in bunkering. That is, this is summarized as follows.

[0158] Return volume in bunkering < Maximum return volume in consideration of cooling apparatus 122 and 126

[0159] In this embodiment, the evaporation gas compressor 121 for compressing evaporation gas of the storage tank 110 and supplying the evaporation gas to the generator engine 130 may be omitted. Instead, liquefied gas of the storage tank 110 is pumped and liquefied, to be supplied to the generator engine 130.

[0160] That is, in this embodiment, resources of the cooling apparatus 122 and 126 cover the evaporation gas flow volume returned in the bunkering, and the evaporation gas compressor 121 is omitted, so that the entire system can be simply configured.

[0161] FIG. 13 is a process flowchart of a gas treatment system in accordance with a tenth embodiment of the present invention.

[0162] Referring to FIG. 13, in the gas treatment system in accordance with the tenth embodiment of the present invention, the entire system is optimized in a manner different from those of the eighth and ninth

embodiments.

[0163] Specifically, in this embodiment, similarly to the ninth embodiment, evaporation of the storage tank 110 may be supplied to the generator engine 130 while the evaporation maximum return volume of the storage tank 110 in consideration of the cooling apparatus 122 and 126 is equal to or greater than the evaporation gas return flow volume in bunkering. This is summarized as follows.

[0164] $\text{Return volume in bunkering} < \text{Maximum return volume in consideration of cooling apparatus 122 and 126} < \text{Maximum return volume in consideration of cooling apparatus 122 and 126} + \text{Compressor treatment volume}$

[0165] However, in this embodiment, the evaporation gas compressor 121 for compressing evaporation gas of the storage tank and supplying the evaporation gas to the generator engine 130 may be independently provided. That is, unlike the eighth embodiment in which the evaporation gas compressors 121 back up each other, in this embodiment, the backup between the evaporation gas compressors 121 is impossible.

[0166] However, this embodiment is configured such that the evaporation gas maximum return volume in consideration of the cooling apparatus 122 and 126 is beyond the evaporation gas return flow volume, it is unnecessary to ensure the backup between the evaporation gas compressors 121.

[0167] However, in order to back up the supply of fuel to the generator engine 130, this embodiment is provided such that at least one of evaporation gas and liquefied gas can be supplied to the generator engine 130. Thus, the supply of the evaporation gas can be backed up to the supply of the liquefied gas.

[0168] As described above, in this embodiment, the evaporation gas

compressor 121 is independently configured while the evaporation gas returned in the bunkering is sufficiently treated, and the supply of the fuel is backed up by using the liquefied gas, so that installation and operation cost can be reduced.

[0169] The present invention is not limited to the embodiments described above, and it will be apparent that a combination of the embodiments or a combination of at least one of the embodiments and prior art may be included as still another embodiment.

[0170] As described above, the present invention has been described based on the embodiments, which are merely exemplary and are not intended to limit the present invention, and those skilled in the art to which the present invention pertains do not depart from the essential technical details of the present embodiment. It will be appreciated that various combinations or modifications and applications not illustrated in the embodiments are possible.

[0171] Simple modifications and changes of the present invention belong to the scope of the present invention, and the specific scope of the present invention will be clearly defined by the appended claims.

CLAIMS:

1. A gas treatment system for transferring liquefied gas from a storage tank of a bunkering ship to a C-type fuel tank provided in a gas propulsion ship, the gas treatment system, comprising:

a bunkering line configured to supply the liquefied gas of the storage tank to the fuel tank;

a bunkering management part configured to control an internal pressure of the storage tank by liquefying evaporation gas of the storage tank, using a refrigerant, and returning the evaporation gas; and

an evaporation gas return line configured to transfer evaporation gas generated in the fuel tank to the bunkering ship in bunkering through the bunkering line,

wherein the bunkering management part lowers the internal pressure of the storage tank to a predetermined pressure or lower before the bunkering, and allow the evaporation gas to be transferred through the evaporation gas return line without compression performed by a separate compressor, by maintaining the internal pressure of the storage tank to be less than that of the fuel tank in the bunkering.

2. The gas treatment system of claim 1, wherein the storage tank is a membrane-type or C-type tank, and

wherein the predetermined pressure is 0.04 barG or 0.2 barG.

3. The gas treatment system of claim 1, wherein the bunkering management part includes a reliquefaction apparatus configured to liquefy evaporation gas, and

wherein the evaporation gas return line transfers the evaporation gas to the reliquefaction apparatus.

4. The gas treatment system of claim 3, wherein the bunkering management part maintains the internal pressure of the storage tank to be less than that of the fuel tank, by relieving the evaporation gas transferred through the evaporation gas return line in the bunkering and returning the relieved evaporation gas to the storage tank.

5. The gas treatment system of claim 1, wherein, when the internal pressure of the fuel tank before bunkering is the first pressure, and the bunkering is performed on the fuel tank of which the internal pressure drops due to introduction of the liquefied gas in the bunkering, the bunkering management part allows internal pressures of the storage tank before the bunkering and in the bunkering to be equal to or lower than that of the fuel tank when the bunkering of the fuel tank is completed.

6. The gas treatment system of claim 5, wherein, when the internal pressure of the fuel tank is a second pressure, and the bunkering is performed on the fuel tank of which the internal pressure rises due to generation of the evaporation gas in the bunkering, the bunkering management part allows internal pressures of the storage tank before the bunkering and in the bunkering to be equal to or lower than that of the fuel tank when the bunkering of the fuel tank is started.

7. The gas treatment system of claim 6, wherein the first pressure is a pressure which is equal to the predetermined pressure or is higher by 0.05 barG to 0.1 barG than the predetermined pressure, and

the second pressure is a pressure which is lower by 0.05 barG to 0.1 barG than the predetermined pressure.

8. The gas treatment system of claim 6, wherein the first pressure is 0.5 barG to 8 barG, and

the second pressure is 0.5 barG or lower.

9. A gas treatment system for transferring liquefied gas from a storage tank of a bunkering ship to a fuel tank provided in a gas propulsion ship, the gas treatment system, comprising:

a bunkering line configured to supply the liquefied gas of the storage tank to the fuel tank;

a bunkering management part configured to control an internal pressure of the storage tank by compressing, cooling, and decompressing evaporation gas of the storage tank without heat exchange with a refrigerant and returning the evaporation gas; and

an evaporation gas return line configured to transfer evaporation gas generated in the fuel tank to the bunkering ship in bunkering through the bunkering line,

wherein the bunkering management part:

lowers the internal pressure of the storage tank to be a predetermined pressure or lower before the bunkering; and

allows the fuel tank to be pressure-accumulated by blocking the transfer of the evaporation gas through the evaporation gas return line in the bunkering or allows the evaporation gas to be transferred through the evaporation gas return line without compression performed by a separate compressor by maintaining the internal pressure of the storage tank to be less than that of the fuel tank.

10. The gas treatment system of claim 9, wherein the storage tank is a membrane-type or C-type tank, and

wherein the predetermined pressure is 0.04 barG or 0.2 barG.

11. The gas treatment system of claim 9, wherein the bunkering management part includes an evaporation gas heat exchanger configured to heat-exchange compressed evaporation gas with evaporation gas discharged from the storage tank, and

wherein the evaporation gas return line transfers evaporation gas between the storage tank and the evaporation gas heat exchanger.

12. The gas treatment system of claim 11, wherein the evaporation gas return line is provided to transfer evaporation gas between the storage tank and the evaporation gas heat exchanger by passing through or detouring the evaporation gas heat exchanger.

13. The gas treatment system of claim 11, wherein the bunkering management part includes:

a plurality of low-pressure compressors provided in parallel to compress evaporation gas of the storage tank and then supply the evaporation gas to a generator engine;

a multi-stage boosting compressor provided at a position branching off between the low-pressure compressor and the generator engine, the multi-stage boosting compressor compressing surplus evaporation gas to 150 barG or higher; and

a decompression valve configured to decompress and liquefy the evaporation gas compressed by the boosting compressor, and

wherein the evaporation gas heat exchanger cools high-pressure evaporation gas, using evaporation gas discharged from the storage tank, between the boosting compressor and the decompression valve.

14. The gas treatment system of claim 13, wherein the bunkering management part sucks the evaporation gas of the storage tank by operating, in parallel, the plurality of low-pressure compressors to lower the internal pressure of the storage tank to the predetermined pressure before the bunkering.

15. The gas treatment system of claim 11, wherein the bunkering management part includes:

- a low pressure compressor configured to compress evaporation gas of the storage tank and supply the evaporation gas to a generator engine;

- a multi-stage high-pressure compressor provided in parallel to the low-pressure compressor, the multi-stage high-pressure compressor compressing the evaporation gas of the storage tank to 150 barG or higher; and

- a decompression valve configured to decompress and liquefy the evaporation gas compressed by the high-pressure compressor,

- wherein the evaporation gas heat exchanger cools high-pressure evaporation gas, using evaporation gas discharged from the storage tank, between the high-pressure compressor and the decompression valve, and

- wherein the high-pressure compressor supplies evaporation gas of an intermediate stage to the generator engine.

16. The gas treatment system of claim 15, wherein the bunkering management part independently operates the low-pressure compressor and the high-pressure compressor according to a liquefied gas storage volume of the storage tank.

17. A gas treatment system for transferring liquefied gas from a

storage tank of a bunkering ship to a fuel tank provided in a gas propulsion ship, the gas treatment system, comprising:

- a bunkering line configured to supply the liquefied gas of the storage tank to the fuel tank;

- a bunkering management part configured to control an internal pressure of the storage tank by supercooling liquefied gas of the storage tank, using a refrigerant, and returning the liquefied gas; and

- an evaporation gas return line configured to transfer evaporation gas generated in the fuel tank to the bunkering ship in bunkering through the bunkering line,

- wherein the bunkering management part:

- lowers the internal pressure of the storage tank to be a predetermined pressure or lower before the bunkering; and

- allows the fuel tank to be pressure-accumulated by blocking the transfer of the evaporation gas through the evaporation gas return line in the bunkering or allows the evaporation gas to be transferred through the evaporation gas return line without compression performed by a separate compressor by maintaining the internal pressure of the storage tank to be less than that of the fuel tank.

18. The gas treatment system of claim 17, wherein the storage tank is a membrane-type or C-type tank, and

- wherein the predetermined pressure is 0.04 barG or 0.2 barG.

19. The gas treatment system of claim 17, wherein the bunkering management part includes:

- a supercooling apparatus configured to supercool liquefied gas, using a refrigerant; and

a refrigerant supply part configured to supply the refrigerant to the supercooling apparatus, and

wherein the refrigerant supply part includes a refrigerant heat exchanger configured to cool the refrigerant, using liquefied gas or evaporation gas, which is supplied from the storage tank to a generator engine.

20. The gas treatment system of claim 17, wherein the refrigerant supply part includes:

a refrigerant compressor;

an inter-refrigerant heat exchanger configured to heat-exchange a compressed refrigerant with a refrigerant heated in the supercooling apparatus;

a refrigerant expander configured to expand the refrigerant passing through the inter-refrigerant heat exchanger after compression; and

the refrigerant heat exchanger configured to cool the compressed refrigerant, using the liquefied gas or the evaporation gas, which is supplied to the generator engine.

21. The gas treatment system of claim 17, wherein the refrigerant supply part includes:

a refrigerant compressor;

the refrigerant heat exchanger configured to heat-exchange a compressed refrigerant with a refrigerant heated in the supercooling apparatus and liquefied gas or evaporation gas, which is supplied to the generator engine; and

a refrigerant expander configured to expand the refrigerant passing through the refrigerant heat exchanger after compression.

22. A bunkering ship comprising the gas treatment system of any one of claims 1 to 21.