

DESCRIPTION

Title of Invention

SHIP

Technical Field

[0001]

The present disclosure relates to a ship.

This application claims the right of priority based on Japanese Patent Application No. 2019-228783 filed with the Japan Patent Office on December 19, 2019, the content of which is incorporated herein by reference.

Background Art

[0002]

PTL 1 discloses loading a liquefied gas such as LNG (Liquefied Natural Gas) into a tank through a gas loading pipe system led from the vicinity of a top portion of the tank to the vicinity of a bottom portion of the tank.

Citation List

Patent Literature

[0003]

[PTL 1] Japanese Patent No. 5769445

Summary of Invention

Technical Problem

[0004]

Incidentally, there is a demand for transporting liquefied carbon dioxide by using a tank as in PTL 1. In the liquefied carbon dioxide, the pressure of a triple point (hereinafter referred to as triple point pressure) at which a gas phase, a liquid phase, and a solid phase coexist is higher than the triple point pressure of LNG or LPG. Therefore, the triple point pressure becomes close to the operating pressure of the tank. In a case where the liquefied carbon dioxide is contained in the tank, for the following reasons, there is a possibility that the liquefied carbon dioxide may be solidified to generate dry ice.

[0005]

In the tank containing liquefied gas as in PTL 1, there is a case where a lower end of a loading pipe, which is open in the tank, is disposed at a lower portion in the tank. With such disposition, the vicinity of the opening of the loading pipe is pressurized with an increase in liquid head. Therefore, flash evaporation of the liquefied gas discharged from the opening of the loading pipe can be suppressed. However, in a pipe top portion disposed at the highest position of the loading pipe, the pressure of the liquefied carbon dioxide inside is reduced by the amount corresponds to the height difference between the liquid level of the liquefied carbon dioxide in the tank and the pipe top portion with respect to the pressure of the liquefied carbon

dioxide at the pipe lower end.

[0006]

As a result, depending on a tank operating pressure, the pressure of the liquefied carbon dioxide becomes equal to or lower than the triple point pressure in the pipe top portion of the loading pipe where the pressure of the liquefied carbon dioxide becomes the lowest, or the liquefied carbon dioxide evaporates, and due to the evaporation latent heat thereof, the temperature of the liquefied carbon dioxide remaining without evaporating is lowered, so that there is a possibility that the liquefied carbon dioxide may be solidified in the pipe top portion of the loading pipe to generate dry ice.

Then, in this manner, if dry ice is generated in the loading pipe, the flow of the liquefied carbon dioxide in the loading pipe is obstructed, so that there is a possibility that the operation of the tank may be affected.

[0007]

The present disclosure has been made in order to solve the above problem, and has an object to provide a ship in which it is possible to suppress the generation of dry ice in a loading pipe and smoothly perform the operation of a tank.

Solution to Problem

[0008]

In order to solve the above problem, a ship according to the present disclosure includes a hull, a tank, and a loading pipe. The hull has a pair of broadsides and a deck. At least a part of the tank is provided to protrude to an upper side with respect to the deck. The tank is capable of storing liquefied carbon dioxide. The loading pipe is provided on a lower side with respect to an upper end of the tank. The loading pipe loads liquefied carbon dioxide, which is supplied from an outside of the ship, into the tank. The loading pipe includes a first portion and a second portion. The first portion extends above the deck. The first portion has a connection part for connection with the outside of the ship. The second portion extends downward from the first portion. The second portion is connected to a lower end of the tank.

Advantageous Effects of Invention

[0009]

According to the ship of the present disclosure, it is possible to suppress the generation of dry ice in a loading pipe and smoothly perform the operation of a tank.

Brief Description of Drawings

[0010]

Fig. 1 is a plan view of a ship according to an embodiment of the present disclosure.

Fig. 2 is a sectional view showing a tank and a loading

pipe provided in the ship according to the embodiment of the present disclosure.

Fig. 3 is a side sectional view showing a tank and a loading pipe provided in a ship according to a modification example of the embodiment of the present disclosure.

Description of Embodiments

[0011]

Hereinafter, a ship according to an embodiment of the present disclosure will be described with reference to Figs. 1 and 2.

(Hull Composition of Ship)

A ship 1 of an embodiment of the present disclosure shown in Figs. 1 and 2 carries liquefied carbon dioxide. The ship 1 includes at least a hull 2, a tank 21, and a loading pipe 30.

[0012]

(Configuration of Hull)

The hull 2 has a pair of broadsides 3A and 3B forming an outer shell thereof, a ship bottom (not shown), and a deck 5. The broadsides 3A and 3B are provided with a pair of broadside outer plates forming the left and right broadsides respectively. The ship bottom (not shown) is provided with a ship bottom outer plate connecting the broadsides 3A and 3B. Due to the pair of broadsides 3A and 3B and the ship bottom (not shown), the outer shell of the

hull 2 has a U-shape in a cross section orthogonal to a bow-stern direction Da. The deck 5 exemplified in this embodiment is an all-deck that is exposed to the outside. In the hull 2, a superstructure 7 having an accommodation space is formed on the deck 5 on the stern 2b side.

[0013]

In the hull 2, a cargo tank storage compartment (a hold) 8 is formed on the bow 2a side with respect to the superstructure 7. The cargo tank storage compartment 8 is recessed toward the ship bottom (not shown) below the deck 5 and is open upward.

[0014]

(Configuration of Tank)

As shown in Fig. 1, a plurality of tanks 21 are provided in the cargo tank storage compartment 8. In the tank 21 in this embodiment, for example, a total of seven tanks 21 are disposed in the cargo tank storage compartment 8. The layout and the number of tanks 21 installed in the cargo tank storage compartment 8 are not limited in any way. In this embodiment, each tank 21 has, for example, a cylindrical shape extending in the horizontal direction (specifically, the bow-stern direction). The tank 21 contains liquefied carbon dioxide L inside. The tank 21 is not limited to a cylindrical shape and may have a spherical shape.

[0015]

As shown in Fig. 2, the tank 21 is provided so as to straddle the spaces above and below the deck 5. That is, at least a part of the tank 21 is provided so as to protrude to the upper side with respect to the deck 5 through an opening portion 5h formed in the deck 5. In the tank 21 of this embodiment, an upper end 21t is provided on the upper side with respect to the deck 5.

The tank 21 is supported through a saddle 22 on a lower deck 6 provided below the deck 5. That is, a lower end 21b of the tank 21 is provided at a distance from the lower deck 6 in a ship height direction (hereinafter, simply referred to as an up-down direction Dv).

[0016]

(Configuration of Loading Pipe)

The loading pipe 30 loads the liquefied carbon dioxide L, which is supplied from the outside of the ship, such as a liquefied carbon dioxide supply facility on land or a bunker ship, into the tank 21. The loading pipe 30 in this embodiment is provided on the lower side with respect to the upper end 21t of the tank 21. The loading pipe 30 includes a first portion 31 and a second portion 32.

[0017]

The first portion 31 extends to follow the deck 5 above the deck 5. A connection part 31j which is provided at a

bunker station or the like and connected to the outside of the ship is formed at one end of the first portion 31. The connection part 31j has, for example, a flange or the like, and is provided on at least one (for example, the broadside 3A) of the broadsides 3A and 3B. The connection part 31j has an opening so as to face the outside in a ship width direction, for example. An end portion of a supply pipe 100 for supplying liquefied carbon dioxide from the outside of the ship, such as a liquefied carbon dioxide supply facility or a bunker ship, can be mounted to or dismounted from the connection part 31j.

[0018]

The second portion 32 is provided to be continuous with the other end of the first portion 31. The second portion 32 has a downward extension portion 32a, an under-tank extension portion 32b, and a tank connection portion 32c.

[0019]

The downward extension portion 32a extends downward in a ship height direction from the first portion 31 that is located above the deck 5. The downward extension portion 32a extends from the space above the deck 5 to the space below the deck 5 through an insertion hole 5g formed in the deck 5 separately from the opening portion 5h, or the opening portion 5h. A lower end portion of the downward

extension portion 32a is disposed on the lower side with respect to the lower end 21b of the tank 21 in the up-down direction Dv.

[0020]

The under-tank extension portion 32b is provided to be continuous with a lower end portion of the downward extension portion 32a. The under-tank extension portion 32b extends to follow the lower deck above the lower deck 6. The under-tank extension portion 32b is disposed on the lower side with respect to the lower end 21b of the tank 21 supported by the saddle 22 in the up-down direction Dv.

[0021]

The tank connection portion 32c is provided to be continuous with the under-tank extension portion 32b. The tank connection portion 32c extends so as to rise upward from the under-tank extension portion 32b. The tank connection portion 32c is connected to the lower end 21b of the tank 21. A pipe end 32t of the tank connection portion 32c is connected to a communication opening 21h formed at the lower end 21b of the tank 21. The communication opening 21h makes the inside and the outside of the tank 21 to communicate with each other at the lower end 21b of the tank 21. Here, the pipe end 32t of the second portion 32 is provided at the same height as an inner peripheral surface 21f at the lower end 21b of the tank 21 in the up-down

direction Dv. In other words, the pipe end 32t of the second portion 32 does not protrude toward the upper side (in other words, the inside of the tank 21) with respect to the inner peripheral surface 21f at the lower end 21b of the tank 21, and is provided to be flush with the inner peripheral surface 21f. The pipe end 32t of the second portion 32 is open vertically upward on the inner peripheral surface 21f at the lower end 21b of the tank 21.

[0022]

In this way, the second portion 32 is connected to the lower end 21b of the tank 21. The second portion 32 is connected to the lower end 21b of the tank 21 from vertically below. The loading pipe 30 as described above discharges the liquefied carbon dioxide L, which is supplied from the outside of the ship, into the tank 21 from the lower end 21b of the tank 21.

[0023]

(Operation and Effects)

In the ship 1 of the above embodiment, the loading pipe 30 is provided on the lower side with respect to the upper end 21t of the tank 21. In this way, a height difference Δh between a liquid level Lf of the liquefied carbon dioxide L in the tank 21 and the first portion 31 which is at the highest position of the loading pipe 30 can be reduced as compared with a case where the loading pipe

30 is connected into the tank 21 from the upper portion (the upper end 21t) of the tank 21.

By reducing the height difference Δh between the first portion 31 and the liquid level L_f of the liquefied carbon dioxide L in the tank 21, it is possible to suppress a decrease in the pressure of the liquefied carbon dioxide L in the first portion 31 disposed at the highest position of the loading pipe 30. As a result, the pressure of the liquefied carbon dioxide L in the first portion 31 of the loading pipe 30 can be restrained from approaching a triple point pressure, and therefore, it is possible to suppress the generation of dry ice due to the solidification of the liquefied carbon dioxide L in the loading pipe 30. Therefore, in a case where the liquefied carbon dioxide L is contained in the tank 21, it is possible to suppress the generation of dry ice in the loading pipe 30 and smoothly perform the operation of the tank 21.

[0024]

Further, in the ship 1 of the above embodiment, the first portion 31 of the loading pipe 30 is provided above the deck 5.

Therefore, it is not necessary to adopt a double pipe or the like for the first portion 31, and thus an increase in cost can be suppressed.

[0025]

Further, in the ship 1 of the above embodiment, the second portion 32 of the loading pipe 30 is connected to the lower end 21b of the tank 21 from below. Therefore, for example, when the liquefied carbon dioxide L in the tank 21 is discharged from the tank 21 by using the loading pipe 30, gravity can be used depending on the position of the liquid level Lf. Therefore, it becomes possible to shorten a pump operation time for discharging liquefied carbon dioxide or to use a pump with a lower capacity, and as a result, it becomes possible to save energy and reduce the size of the pump.

[0026]

Further, in the ship 1 of the above embodiment, the pipe end 32t of the second portion 32 of the loading pipe 30 is provided at the same height as the inner peripheral surface 21f at the lower end 21b of the tank 21 in the up-down direction Dv. Therefore, when the liquefied carbon dioxide L in the tank 21 is discharged, the amount of the liquefied carbon dioxide L remaining in the tank 21 can be suppressed.

[0027]

(Other Embodiments)

The embodiment of the present disclosure has been described in detail above with reference to the drawings. However, the specific configurations are not limited to the

embodiment, and also include design changes or the like within a scope which does not deviate from the gist of the present disclosure.

In the above embodiment, a case where one loading pipe 30 is connected to one tank 21 provided in the hull 2 has been described. However, the loading pipe 30 may be provided such that a plurality of tanks 21 are connected to one loading pipe 30. In this manner, in a case where the plurality of tanks 21 are connected to one loading pipe 30, for example, the second portion 32 that is connected to each tank 21 may be provided to be branched from the first portion 31 of the loading pipe 30. That is, in a case where the plurality of tanks 21 are connected to one loading pipe 30, the loading pipe 30 includes one first portion 31 and a plurality of second portions 32. In a case where the loading pipe 30 includes one first portion 31 and the plurality of second portions 32, a valve (not shown) or the like for interrupting the supply of the liquefied carbon dioxide L to the tank 21 may be provided at each of the second portions 32.

[0028]

For example, as shown in Fig. 3, the under-tank extension portion 32b and the tank connection portion 32c which are connected to each tank 21 may be connected to the first portion 31 and the downward extension portion 32a of

the second portion 32 of the loading pipe 30. That is, the loading pipe 30 may be made such that a plurality of under-tank extension portions 32b and tank connection portions 32c are branched from and connected to the first portion 31 and the downward extension portion 32a of the second portion 32 of one loading pipe 30. Also in this case, a valve (not shown) for interrupting the supply of the liquefied carbon dioxide L to the tank 21 may be provided in each of the under-tank extension portion 32b and the tank connection portion 32c that are connected to each tank 21.

[0029]

Further, in the configuration shown in Fig. 3, the plurality of tanks 21 are connected to each other through the under-tank extension portions 32b and the tank connection portions 32c. In a case where the plurality of tanks 21 are connected to each other through the under-tank extension portions 32b and the tank connection portions 32c in this manner, if the heights of the liquid levels L_f of the liquefied carbon dioxide L are different from each other between the plurality of tanks 21, the liquefied carbon dioxide L can be exchanged through the under-tank extension portions 32b and the tank connection portions 32c. That is, it is also possible to send the liquefied carbon dioxide L from a tank 21A, in which the liquid level L_f of the liquefied carbon dioxide L is high, toward a tank 21B, in

which the liquid level L_f of the liquefied carbon dioxide L is low, by gravity without using a pump, for example.

[0030]

In the above embodiment, the first portion 31 of the loading pipe 30 is provided so as to extend above the deck 5 (all-decks exposed to the outside). However, there is no limitation thereto. The first portion 31 of the loading pipe 30 may be provided to follow a deck other than the deck 5, for example, an upper deck provided above the deck 5 or a lower deck such as a freeboard deck provided below the deck 5. In this case, it is favorable if the tank 21 is provided so as to straddle both the spaces above and below the deck (the upper deck or the lower deck) provided with the first portion 31 of the loading pipe 30 and at least the upper end 21t protrudes to the upper side of the deck.

[0031]

<Additional Remark>

The ship 1 described in the embodiment is grasped as follows, for example.

[0032]

(1) The ship 1 according to a first aspect includes: the hull 2 having the pair of broadsides 3A and 3B and the deck 5; the tank 21 having at least a part provided to protrude to the upper side with respect to the deck 5, and capable of storing the liquefied carbon dioxide L ; and the

loading pipe 30 that is provided on the lower side with respect to the upper end 21t of the tank 21 and loads the liquefied carbon dioxide L, which is supplied from the outside of the ship 1, into the tank 21, in which the loading pipe 30 includes the first portion 31 extending above the deck 5 and having the connection part 31j for connection with the outside of the ship 1, and the second portion 32 extending downward from the first portion 31 and connected to the lower end 21b of the tank 21.

As the example of the deck 5, an exposure deck, a lower deck such as a freeboard deck provided below the exposure deck, an upper deck provided above the exposure deck, and the like can be given.

[0033]

In the ship 1, the loading pipe 30 is provided on the lower side with respect to the upper end 21t of the tank 21. In this way, the height of the highest position of the loading pipe 30 can be reduced as compared with a case where the loading pipe 30 is connected into the tank 21 from the upper portion of the tank 21. The pressure of the liquefied carbon dioxide L at the highest position of the loading pipe 30 is lowered by the amount corresponding to a head pressure according to the height difference with respect to the pressure of the liquefied carbon dioxide L stored in the tank 21. However, the height of the highest position of

the loading pipe 30 is reduced, so that it is possible to suppress a decrease in the pressure of the liquefied carbon dioxide L at the highest position of the loading pipe 30. As a result, it is possible to restrain the pressure of the liquefied carbon dioxide L at the highest position of the loading pipe 30 from approaching the triple point pressure. In this way, it is possible to suppress the generation of dry ice due to the solidification of the liquefied carbon dioxide L in the loading pipe 30. As a result, in a case where the liquefied carbon dioxide L is contained in the tank 21, it becomes possible to suppress the generation of dry ice in the loading pipe 30 and smoothly perform the operation of the tank 21.

[0034]

(2) In the ship 1 according to a second aspect, in the ship 1 of the above (1), the second portion 32 is connected to the lower end 21b of the tank 21 from below.

[0035]

In the ship 1, the second portion 32 of the loading pipe 30 is connected to the lower end 21b of the tank 21 from below. Therefore, for example, when the liquefied carbon dioxide L in the tank 21 is discharged from the tank 21 by using the loading pipe 30, gravity can be used depending on the position of the liquid level Lf. Therefore, it becomes possible to shorten a pump operation time for

discharging liquefied carbon dioxide or to use a pump with a lower capacity, and as a result, it becomes possible to save energy and reduce the size of the pump.

[0036]

(3) In the ship 1 according to a third aspect, in the ship 1 of the above (2), the pipe end 32t of the second portion 32 that is connected to the lower end 21b of the tank 21 is provided at the same height as the inner peripheral surface 21f of the lower end 21b of the tank 21 in the up-down direction.

[0037]

In the ship 1, the upper end 21t of the second portion 32 of the loading pipe 30 is provided at the same height as the inner peripheral surface 21f at the lower end 21b of the tank 21 in the up-down direction, and therefore, when discharging the liquefied carbon dioxide L in the tank 21, the amount of liquefied carbon dioxide L remaining in the tank 21 can be suppressed.

Industrial Applicability

[0038]

According to the ship of the present disclosure, it is possible to suppress the generation of dry ice in a loading pipe and smoothly perform the operation of a tank.

Reference Signs List

[0039]

1: ship
2: hull
2a: bow
2b: stern
3A, 3B: broadside
5: deck
5g: insertion hole
5h: opening portion
6: lower deck
7: superstructure
8: cargo tank storage compartment
21, 21A, 21B: tank
21b: lower end
21f: inner peripheral surface
21h: communication opening
21t: upper end
22: saddle
30: loading pipe
31: first portion
31j: connection part
32: second portion
32a: downward extension portion
32b: under-tank extension portion
32c: tank connection portion
32t: pipe end

100: supply pipe

Da: bow-stern direction

Dv: up-down direction

L: liquefied carbon dioxide

Lf: liquid level

Δh : height difference

Claims

[Claim 1]

A ship comprising:

a hull having a pair of broadsides and a deck;

a tank having at least a part provided to protrude to an upper side with respect to the deck, and capable of storing liquefied carbon dioxide; and

a loading pipe that is provided on a lower side with respect to an upper end of the tank and loads liquefied carbon dioxide, which is supplied from an outside of the ship, into the tank,

wherein the loading pipe includes

a first portion extending above the deck and having a connection part for connection with the outside of the ship, and

a second portion extending downward from the first portion and connected to a lower end of the tank.

[Claim 2]

The ship according to claim 1, wherein the second portion is connected to the lower end of the tank from below.

[Claim 3]

The ship according to claim 2, wherein a pipe end of

the second portion that is connected to the lower end of the tank is provided at the same height as an inner peripheral surface of the lower end of the tank in an up-down direction.